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ABSTRACT

Thirteen activities are presented that focus on a common phenomenon of a child's world: energy. These activities relate energy, how it occurs, how it is used, and how to use it safely. Each activity includes the purpose, introduction, background, procedure, materials, estimated time for the activity, typical results, safety notes, and more ideas. Student worksheets are provided for some steps in the procedure. Activities follow questions such as: What is sound and how does it travel?; Where does heat go?; What is static electricity?; and How can we get energy from matter? Safety is emphasized on many of these worksheets. Take-home letters are also provided so that parents can help children to develop safe energy habits. Included are a glossary, resource section, and a matrix where activities are cross referenced with the understandings, skills, and attitudes listed in the New York State elementary science syllabus. (KR)

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Energy and Safety:

Science Activities for Elementary Students

Level II
(Grades 3-4)

from the
New York Energy
Education Project

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Acknowledgements

To Teachers

Children and science go well together. When children are being themselves, they are being scientific: observing things, asking questions, handling objects, noticing similarities and discrepancies, figuring out how something happens.

The activities that follow try to take advantage of those things that children do naturally. We've focused on a common phenomenon in the child's world: the phenomenon of energy. We've arranged a series of experiences related to energy, to how it occurs, how it is used, and how to use it safely.

We hope that you and your students will enjoy these experiences together.

The Format

The Teacher's Pages

Each activity starts with a question. The material immediately following the question is for you, the teacher.

In the Background section, key words are underlined. These words are defined in the Glossary.

The Understandings, Skills, and Attitudes are taken from the New York State Elementary Science Syllabus, soon to be available. In a few cases the wording of the Understandings has been changed to better fit the activity.

The Procedure is arranged in numbered steps. The Materials and the Safety Notes are numbered to match the steps in the Procedure.

The Student's Pages

Student worksheets are provided for some steps in the Procedure. Safety is emphasized on many of these worksheets because the use of energy involves potential hazards in many situations. Students can learn, like scientists, to satisfy their curiosity without getting hurt.

Many activities include Take-home Letters. In most cases, the use of the letters is discretionary and not necessary to the activities. We recommend using the letters because parents and guardians can help children to develop safety energy habits. Each letter includes a space for the student's name and one for the teacher's signature.

Glossary

The key words from the Background section of each activity are defined in the Glossary.

Resources

More materials for students on the same topics are listed by activity in the Resources section. You may wish to use some of this material to introduce or reinforce an activity.

Matrix

In the Matrix the activities in this booklet are cross referenced with the Understandings, Skills, and Attitudes of the New York State Elementary Science Syllabus.

Safety Note for Teachers

Students should wear protective goggles whenever any of the following are being used:

*Hot Plates

*Any Flame (Candle, etc.)

*Rubber Bands

*Any Chemicals (Vinegar, etc.)

The use of appliances or of any flame should be handled as a teacher demonstration.

Level II Activities

Grades 3-4

	Question	Purpose
1.	What forms of energy can be found around us?	To enable students to identify and name several forms of energy, and become aware that energy can be converted from one form to another.
2.	What is sound and how does it travel?	To allow students to experience sound as vibrations of matter and to experiment with the way it is transmitted through various materials.
3.	How does the sun's energy work in nature?	To allow students to observe and describe the effect of sunlight over time on the growth of plants and on the water cycle.
4.	How is energy used in producing our food?	To introduce students to the extensive use of energy required to get food from its sources to our tables.
5.	Where does heat go?	To give students the opportunity to observe how heat travels, how warm objects lose heat, and how certain factors can slow heat loss.
6.	What is insulation and how does it help us?	To have students experiment to discover materials that effectively reduce heat transfer.
7.	What is static electricity?	To allow students to experience and describe several effects caused by static electricity.
8.	How does electrical energy travel?	To allow students to learn how a complete electrical circuit works.
9.	What are the best pathways for electricity to travel on?	To allow students to discover that some materials conduct electricity and others do not.
10.	How does electricity get to our homes?	To enable students to diagram a typical community electrical distribution system from generation to end use.
11.	How can we get energy from matter?	To introduce students to the concept that some materials contain energy stored in chemical form, which can be released in different ways.
12.	What are the different kinds of batteries, and which are best?	To show students through an experiment and a computer program that the value of energy products cannot be determined by considering price alone.
13.	Will we run out of energy? Can we conserve it?	To introduce students to the principles of energy conservation.

1. Question: What forms of energy can be found around us?

Purpose

To enable students to identify and name several forms of energy, and become aware that energy can be converted from one form to another.

Introduction

Students perform or observe simple experiments, and classify the forms of energy and energy conversions involved in each.

Background

Energy exists in a variety of forms: mechanical (motion), heat, light, sound, electrical, magnetic, gravity, chemical, etc.

Energy can be transferred from one object to another, often changing form in the process. In this activity students will observe forms of energy and how energy moves from object to object, and changes from one form to another.

Understandings

Energy can exist in one of several forms.

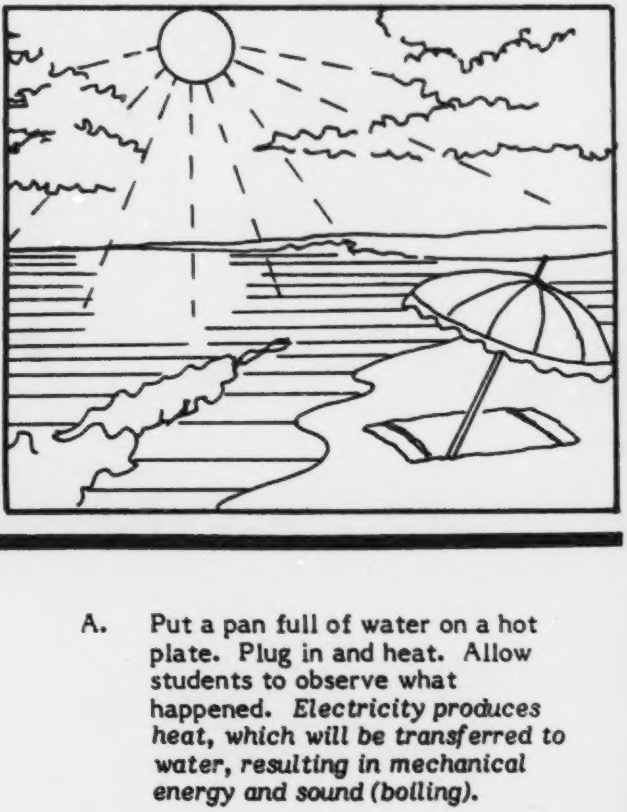
Skills

Observing
Classifying

Attitudes

Wanting to know about and understand the natural world.

Procedure



1. Set up the various experiments on separate desks.

2. List on the board names of forms of energy elicited from the students. If they offer many incorrect suggestions or have few to offer, suggest or give examples and let children name the form of energy. Be sure that students understand each word. The list should include: heat, light, sound, gravity, motion (mechanical), electrical, and chemical energy.

3. Have a student assist you to perform each experiment except those with hot plate (A) and matches (D). Have other students observe and record on the sheets provided. Guide their responses by encouraging accurate and detailed observation.

A. Put a pan full of water on a hot plate. Plug in and heat. Allow students to observe what happened. *Electricity produces heat, which will be transferred to water, resulting in mechanical energy and sound (boiling).*

B. Line a shallow box with black plastic. Punch a hole in each end. Cover the box with clear plastic wrap and stand on a sunny windowsill with one hole up. Have students place a hand over the hole to feel what happens. *Sunlight is absorbed by the black surface and turns to the heat. Plastic wrap blocks the heat. Air in box heats up, expands, and is pushed out the top hole by cool, dense air entering at the bottom.*

C. Put baking soda in one corner of a baggie and tie that corner off with a twistie. Pour vinegar into the other corner and close the top of the bag with a twistie. Remove the first twistie and let the vinegar and baking soda mix. *Chemical energy is released by combining two chemicals, resulting in mechanical energy and gas release (foaming and bubbling, inflation of bag).*

D. Light a match or cigarette lighter. Observe. Use the flame to light a candle. Observe. *Mechanical energy (striking) produces heat (from friction) resulting in the release of chemical energy in the match or lighter fluid, producing heat and light; heat transferred to the wick and wax of the candle starts the release of their chemical energy as heat and light.*

E. Set up a teeter-totter arrangement with a meter stick and some books. Balance 2 chalkboard erasers on one end. Hold a book 10 centimeters over the other end and let go. Observe. Repeat the procedure, dropping the book from 50 centimeters instead of 10. *Gravitational energy results in mechanical energy in the falling book, which transfers to the meter stick and the erasers. The higher the book is raised, the more potential energy it contains.*

F. Switch an empty flashlight or calculator on and off. Load with batteries and try again. Observe. *Chemical energy (batteries) converts to electricity which heats the bulb filament, producing light.*

Students may also observe other forms of energy involved in some of the experiments, such as sound and gravity.

4. Review the experiments and clarify student responses to the What Happened and Why? sheet. Be certain that students understand the forms of energy used and the transferral from one form to another.

5. Make the safe materials available so students may experiment independently and make additional comments.

Materials

3. What Happened and Why? sheets for students

   A. hot plate, saucepan, outlet, water
   B. shoe box lid, black plastic, clear plastic wrap, tape, scissors.
   C. plastic baggie, two twisties, 2 tablespoons of baking soda, a quarter cup of vinegar
   D. match or cigarette lighter, candle, candle holder
   E. meter stick, several books, 2 chalkboard erasers
   F. flashlight or calculator, appropriate batteries

Estimated Time for Activity

1 hour

Typical Results

See notes in italics after each experiment in the Procedure section.

Safety Notes

1. Do experiments with hot plate (A) and matches (D) as demonstrations. Children should observe from a distance.

More Ideas

Introduce the lesson by setting up a domino pathway. Push the first domino and have students observe the rest falling in turn. This can lead to a discussion of forms of energy and energy transfer. Students may enjoy designing their own pathways.

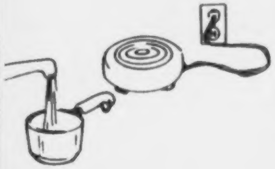
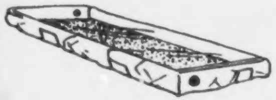
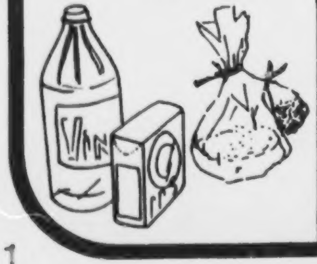
Let students check the baking soda and vinegar with a thermometer to see whether heat gain or loss results.

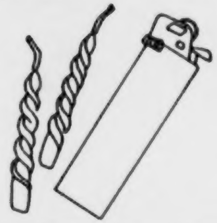
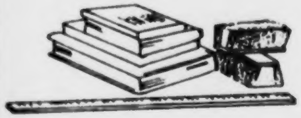
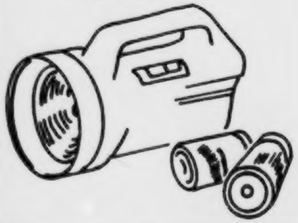
Let students change the fulcrum (balance point) of the teeter-totter to see whether that affects the energy transfer from book to erasers.

Design different kinds of solar collectors and use thermometers to see which heat air the most.

Have an inventors' box including objects students can use to invent machines to demonstrate mechanical energy, muscular energy, gravity, and the transfer of one form to the other.

What Happened and Why?

	Tell what happened.	Draw what you saw happening.	What form of energy was used?	What other forms of energy could you observe?
A. Pan of water on hot plate 				
B. Box covered with plastic 				
C. Vinegar and baking soda 				

	Tell what happened.	Draw what you saw happening.	What form of energy was used?	What other forms of energy could you observe?
D. Lighter with candle 				
E. Meter stick, book, and erasers 				
F. Flashlight and batteries 				

Save and be safe.

Energy makes things happen.
Be sure to use it safely.

1-5

To ________________________ Folks,

Today the class began a series of activities about energy. The class will be learning about the various forms of energy in our world, what they do, and how to conserve them and use them safely. Today the class saw some examples of how heat, light, sound, gravity, motion, electrical, and chemical energy act and interact.

____

2. Question: What is sound and how does it travel?

Purpose

To allow students to experience sound as vibrations of matter and to experiment with the way it is transmitted through various materials.

Introduction

Students observe that vibration causes sound and learn through experimentation that sound can be transmitted through air, water, and solids with varying effectiveness.

Background

Sound is made by objects vibrating. We hear sound when the vibrating object makes our eardrums vibrate also. The vibration of an object can be communicated to our ears through a variety of media--air, water, solids--with varying effectiveness. The nature of the medium (how well it vibrates) will determine the success of the transmission. But in any case, sound must have a medium to transmit the vibration. It will not travel through a vacuum.

Since sound is vibration, it is mechanical energy in a sense. The vibrations can hit things, bounce off of them, and even break them.

Understandings

Sound energy can move from one object to another. It moves differently through air, liquids, and solids.

Skills

Observing
Recording data
Inferring
Formulating hypotheses
Interpreting data
Acquiring information through reading

Attitudes

Welcoming the unknown or the ambiguous.

Valuing careful, systematic investigation as useful.

Sound can be used to generate an electric current. A current can then be used to reproduce the sound vibrations at some destination: a radio, stereo speaker, phone receiver, etc.

Procedure

1. Give each student a rubber band. Instruct them to put it between their thumb and "pointer" finger and stretch the band taut. Have them strum the rubber band and observe.

   Discuss their observations and ask: What causes the sound? How does the sound get from the rubber band to your ear? How far do you think the sound can travel? How fast can it travel? How are we able to hear it?

2. Experiment with voices and hearing. Have students say ho-ho-ho with fingers

on voice boxes. Do the same with one hand in front of the mouth. Have students listen to a sound from a distance, then cup both hands behind ears and listen again. Discuss the results.

3. Ask: Can sound travel through things? Can it travel through water? Can it travel through air? Can it travel through space? Tell students that they will be investigating sound and how it travels.

4. Hand out How does sound travel? sheets and set up the water container in a central location. Let students carry out instructions from their sheets and fill in answers.

5. Discuss the results of students' individual investigations. Ask: Why is sound energy? If energy does work, what work does sound do? Read and discuss Sound gets around. It is effective if a guitar or a tuning fork can be used to demonstrate the explanation of sound as a vibration, as explained on the sheet.

Materials

1. rubber bands

4. How does sound travel? sheets; large container (bucket or aquarium) full of water; 2 spoons or pencils
5. Sound gets around sheets. (optional: guitar or tuning fork)

Estimated Time for Activity

1 hour

Typical Results

Students should be able to feel their voice boxes vibrate. The wood of the desk and the water in the bucket will transmit sound well. The sound should be louder than the same sound transmitted through air.

Safety Notes

Point out that because sound is energy it can actually damage your eardrums if it is too loud. Use safety goggles when students experiment with rubber bands.

More Ideas

Make a variety of rhythm instruments available so that students may determine what part of the instrument is vibrating to produce sound. Expand this using brass, string, and woodwind instruments.

Try making musical instruments: a kazoo from a comb covered with cellophane, water glasses or bottles filled to different levels, cigar box guitars. Experiment with sounds that can be created with different materials.

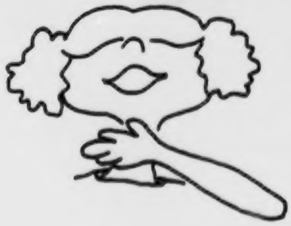
Construct paper cup and string "telephones". Discuss how the sound is transmitted from one cup to the other.

Try different materials to see which transmit sound best. Look for information on how hearing aids, phonograph records, telephones, and sonar work.

Use the time lapse between lightning and thunder to calculate the distance of the lightning bolt. (Sound travels at about 1087 feet - 1/5 mile - per second.)

How does sound travel?

A.

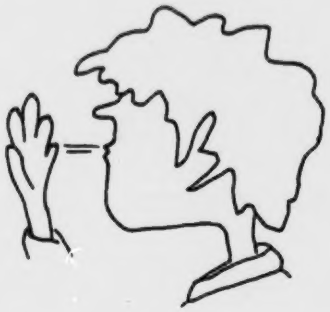


1. Put your hand over your voicebox (Adam's apple). Say "ahah!"

   Say your name.

   What did you feel?

   ____



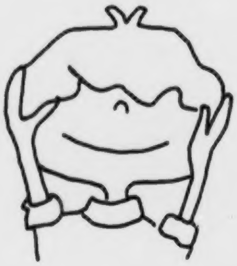
2. Put your other hand in front of your mouth. Say "pow!"

   What did you feel?

   ____

3. Cup your hands over your ears so that no air can get in. What happens to the sounds around you?

   ____



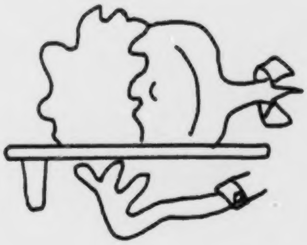
4. Think about the things you just did. Can you tell what makes the sound of your voice?

   ____

   How does that sound travel from you to other people?

   ____

B.



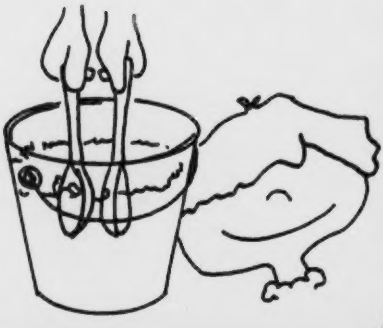
1. Put your ear against the top of your desk. Scratch the underside of the desk with your fingers. What did you notice?

   ____

2. Lift your head and scratch the desk again. What did you notice?

   ____

C.



1. Work with a partner. You'll need two pencils or spoons and a large bucket of water. Have your partner tap the spoons together about 6 inches from your ear. Then press your ear to the side of the bucket. Have your partner tap the spoons together underwater. What did you notice?

   ____

   Does sound travel well through water?

   ____

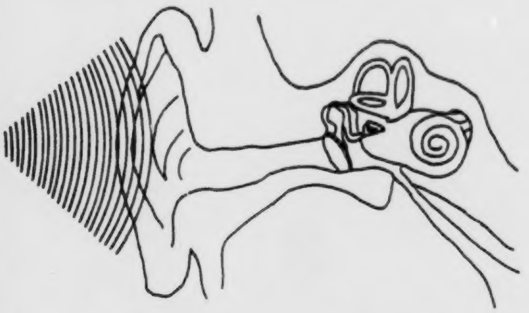
Sound gets around.

Sound is energy. When you hear a sound, that means something is moving. When something moves back and forth very fast, we say it vibrates. Sound happens when something vibrates.

Your voicebox vibrates to make your voice. A guitar vibrates when it makes music. When the wind blows, we hear the air vibrating.

But how does sound travel? How does the sound get from the guitar to you, so that you can hear it?

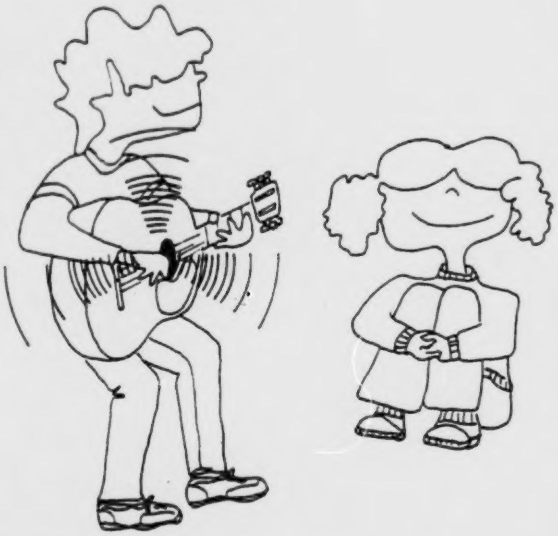
When something vibrates, the things that touch it vibrate too. Sound energy that passes from one thing to another is called sound waves. So when the guitar vibrates, it makes the air around it vibrate. The sound waves spread through the air. Your ear is like a scoop for catching sound waves in the air. The sound waves strike a thin piece of membrane in your ear, called your eardrum. The eardrum passes the vibration to tiny bones in your middle ear. The bones vibrate a tube full of liquid. This carries the vibration to nerves that go to your brain.



Some solid things, like the wood of a guitar or the metal of a tuning fork, vibrate very well, so they can transmit waves. If you put your ear against the guitar, the sound will be loud and you'll feel the vibration.

Because sound is energy, it can make things happen. The army uses sound waves (sonar) to track things. Doctors use sound waves (ultrasound) to probe where they cannot see inside the body. And we all use sound to communicate.

Sound energy can even break things. That is why you should be careful with sound. Music that is too loud can actually damage your eardrums. And screaming too loudly can damage your voicebox. Use sound safely!



3. Question: How does the sun's energy work in nature?

Purpose

To allow students to observe and describe the effect of sunlight over time on the growth of plants and on the water cycle.

Introduction

Students construct 3 terrariums, place them in varying conditions of sunlight, observe them for a period of time, and draw conclusions about the importance of sunlight to plant growth and the water cycle.

Background

A terrarium is a self-contained ecosystem that needs little attention. The study of this small closed system can give students insight into the workings of processes in nature, especially photosynthesis and the water cycle.

In photosynthesis, plants use the sun's energy to manufacture food from carbon dioxide from the air, and water. The resulting carbohydrates are stored in the plants' leaves, stems, and roots. Carbohydrates are actually stored chemical energy, nourishing the plants' growth as well as providing food for animals including humans.

In the water cycle, water is circulated in nature by the sun's energy. Sunlight evaporates water from the earth's surface. The vapor rises, cools, and condenses into water or ice, forming clouds. Rain and snow fall, completing the cycle.

Understandings

When energy interacts with objects in a system the properties of the objects may be changed.

Skills

Observing
Measuring
Recording data
Manipulating materials
Interpreting data

Attitudes

Appreciating the natural world.

Valuing careful, systematic investigation.

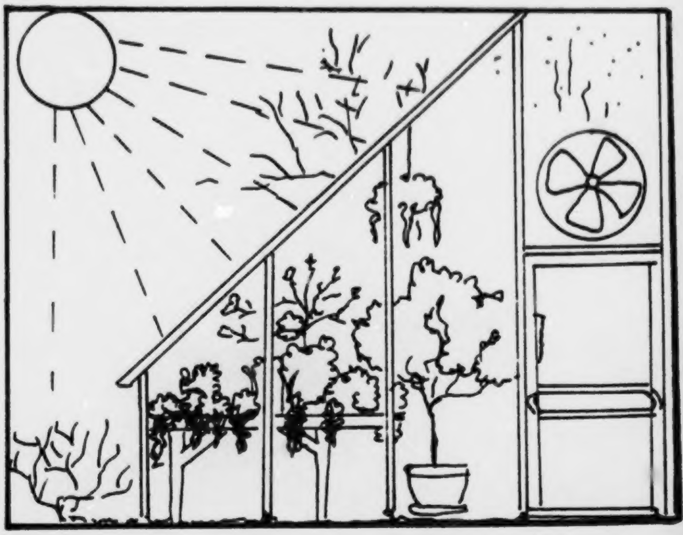
Enjoying working with living and nonliving materials.

Procedure

1. Have students collect materials to make three terrariums: stones, soil, plants, and containers. Clean containers and wash stones. Using a hammer, break up charcoal between sheets of newspaper.

2. Go over the instruction sheet: Make a terrarium. Note: It is important that construction and contents of all three terrariums be as similar as possible.

3. Group students so that either
   a. each group constructs one terrarium or
   b. each group does one step in constructing all three terrariums.



4. Have students select three locations: full sunlight, indirect sunlight, full shade. Place one terrarium in each location. Set each so that the thermometer can be read and plant growth can be observed without moving the terrarium.

5. Distribute the record sheet and go over it with the students. Allow three times for students to record their observations over four weeks.

6. Discuss the observations made.

   Ask: Did some plants do better than others? Why do you think this happened? Which terrarium was the warmest? Did the heat affect the terrarium in any way? What else was observed? What caused those things to happen?

   Ask: Where does the moisture on the top and sides come from? (Discuss the water cycle.) What is the only factor that was different for each terrarium? (Amount of sunlight.) What do you think was the reason for differences in the 3 terrariums at the end of the experiment? (Amount of sunlight.) What affect does sunlight have on growing, living plants?

Materials

2. 3 large containers of glass or clear plastic with tops (plastic shoeboxes, gallon jars or aquariums with plastic wrap for tops, or 2-liter plastic soda bottles cut in half); tape or rubber bands; small stones; a few charcoal briquets; soil; small plants (baby tears, creeping charlie, moss, weeds); felt marker; hammer; 3 thermometers; water; cardboard; Make a terrarium sheets

5. Terrarium Record Sheets

Estimated Time for Activity

1 hour for collection of materials and construction of terrariums

1 hour for observation and record-keeping over 4 week period

Typical Results

Direct sunlight may bleach leaves or dehydrate plants, causing them to wilt. Shade may cause plants to grow thin and weak-looking. The closed terrariums will probably warm up. Water from plants and soil will probably evaporate and rise in heated air to the top. It will condense on the top and drip (rain) on the plants. The terrarium in partial sunlight should perform closest to nature. Early observations may not reveal any differences.

Safety Notes

1. Supervise plant collecting to avoid poisonous plants.

More Ideas

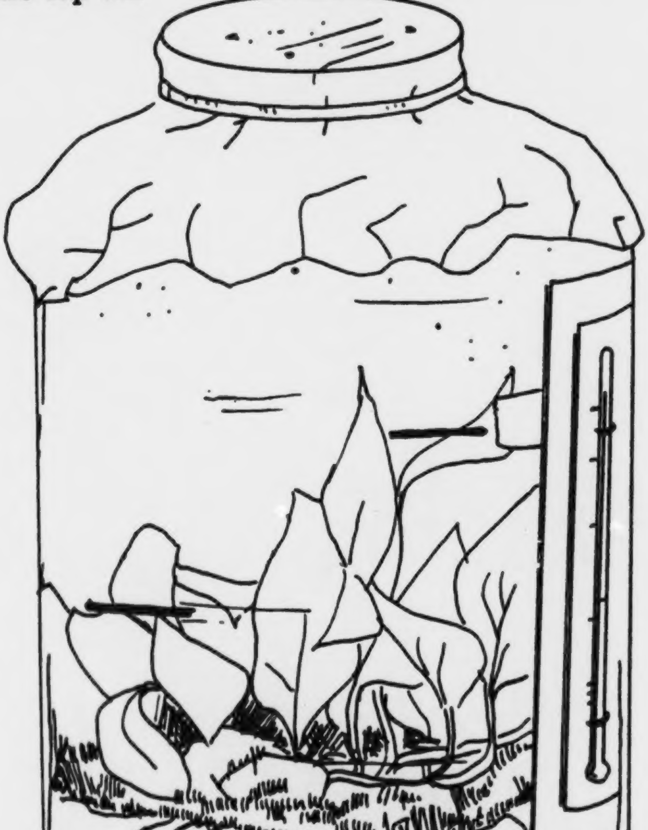
Test other variables such as different soils, plants, amounts of water. Remember however, to test only one variable per experiment; all other factors for all 3 terrariums must remain the same.

Visit a garden to observe how different plants flourish in different conditions.

Tour a greenhouse to see how conditions are made favorable for growing plants, starting plants, and forcing blossoms.

Make a terrarium.

1. Clean your container.
2. Put a layer of small stones in the bottom.
3. Add a thin layer of broken charcoal.
4. Add about 2 centimeters of soil.
5. Place the plants with their roots on the soil. Sprinkle more soil around them until the roots are well covered.
6. Press down the soil over the roots.
7. Water with **a few drops** of water.
8. Place a thermometer at one side, facing out, with cardboard behind it.
9. Use a marker to make a line on the outside of the container to show the starting height of each plant.
10. Put the top on.



Terrarium Record Sheet

Terrarium	Date	Time	Temperature	Plant changes I saw	Other changes I saw
Sunshine					
Indirect sunshine					
Shade					

3-4

4. Question: How is energy used in producing our food?

Purpose

To introduce students to the extensive use of energy required to get food from its sources to our tables.

Introduction

Students trace a familiar food from its origins, sequence the steps in the food production system, and record the many forms of energy used.

Background

The human food chain starts with energy from the sun, which is stored as chemical energy in plants. Animals consume plants and convert the stored energy to heat, motion, and new chemical combinations. So the food chain is also an energy chain from the sun to the point of use.

However, there are many other forms of energy involved in food production, because our food system is large and complex.

Farmers use fertilizers and pesticides that are byproducts of fossil fuels. They use equipment and machinery that runs on fuel and electricity.

Processing plants also use energy to clean, reshape, preserve, and package food. Supermarkets use energy for refrigeration and other needs. In our homes we preserve, process, and cook our food with energy.

In each step of the food system, transportation is also involved. From farm to processing plant to market to home, many of our foods travel long distances.

Understandings

Within systems, the interactions of materials and energy change their forms and properties. A group of interacting objects is called a system.

Skills

Interpreting data
Classifying
Creating models
Developing vocabulary
Acquiring and communicating information

Attitudes

Appreciating the natural world as an essential resource in fulfilling human needs.

Valuing the practical and technological.

In round figures (leaving out the energy of the sun) our food system uses energy in the following percentages:

production (growing crops and raising animals) =	20%
processing and packaging =	30%
transportation =	5%
marketing =	15%
preparation (in homes and restaurants) =	30%

Procedure

1. Start with a discussion of hamburgers (or some other popular food).

   Ask: Where does hamburger come from? Where does beef come from? How does a cow or a steer grow? Where does the feed come from? What

makes the plants grow? Does a hamburger come from the sun's energy?

2. Continue the topic.

   Ask: Is there other energy involved in producing the hamburger? How did the hamburger get to you? What kept it from spoiling in the store? How was the meat cut and chopped? How was it packaged?

3. Distribute the Energy in Our Food System sheets. Have students fill in their answers and then discuss.

4. Distribute the Parts of the Food System and Putting a Food System Together sheets. Have students cut out, sequence, and paste the parts in proper order on the food system. It may be helpful to discuss which step each picture illustrates before children cut and paste.

5. Go over the finished sheet step by step.

   Ask: Do you think food or energy may be wasted at this step? Do you think other materials may be wasted? How might that energy, food, or other materials be saved?

Materials

3. Energy in Our Food System sheets, pencils

4. Parts of the Food System and Putting a Food System Together sheets, scissors, glue

Estimated Time for Activity

1 hour

Safety Notes

None

More Ideas

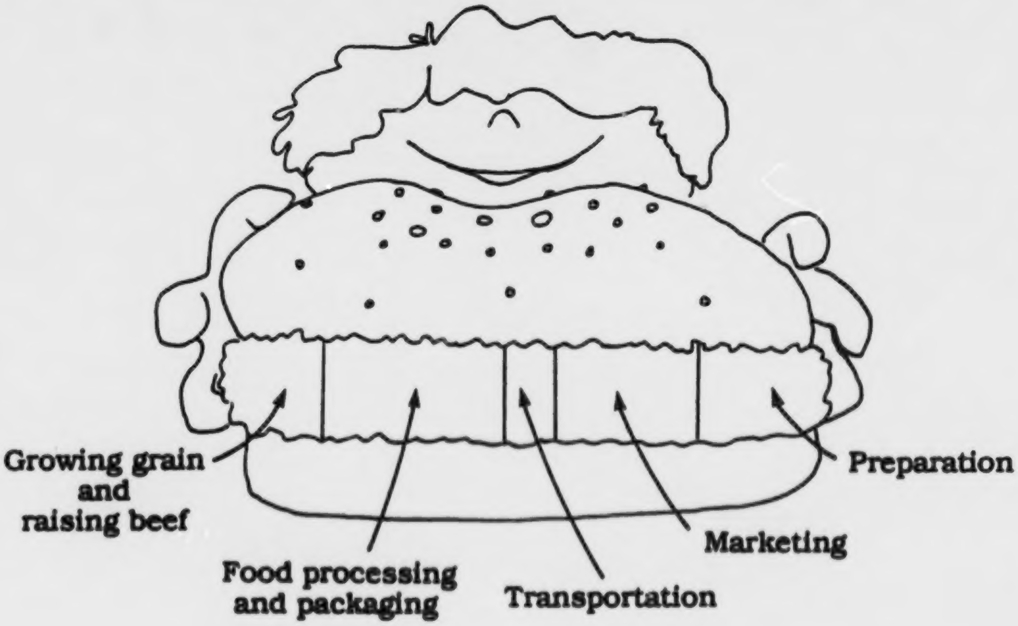
Trace other familiar foods back to their origins. Use a U.S. map and a U.S. almanac to trace the sources of the parts of a favorite meal.

Research foods that come from outside the U.S. - spices, for example - and find out how far they have traveled.

Tour a large supermarket. Observe uses of energy within the store to prepare, preserve, and market foods.

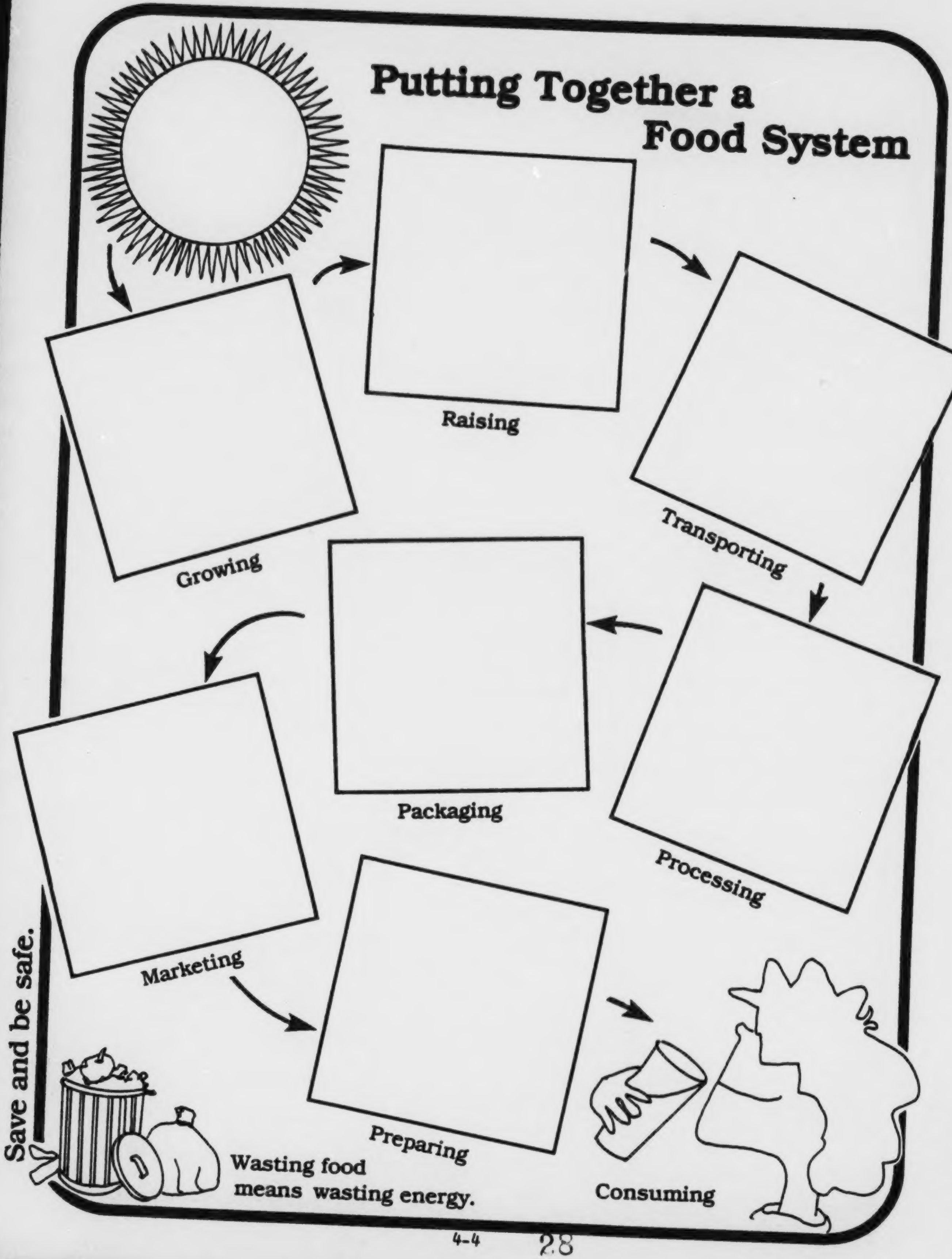
Learn about the diets of people in other countries and cultures. Try to figure out if their food takes more or less energy to produce.

Energy in Our Food System


Growing grain and raising beef
Food processing and packaging
Transportation
Marketing
Preparation

	What does it mean?	What energy is used?
Growing and raising		
Food processing and packaging		
Transporting		
Marketing		
Preparing		

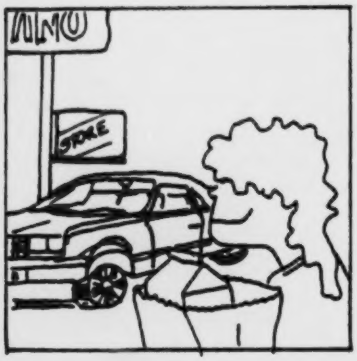
Putting Together a Food System

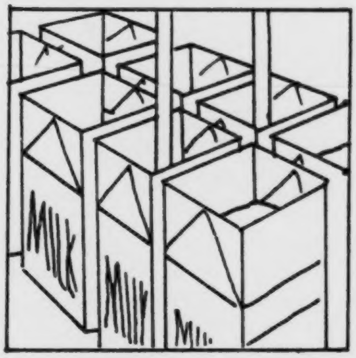

Growing
Raising
Transporting
Processing
Packaging
Marketing
Preparing
Consuming

Save and be safe.

Wasting food means wasting energy.

Parts of the Food System

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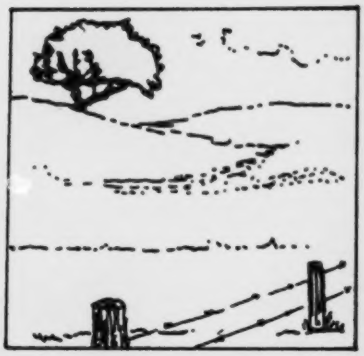
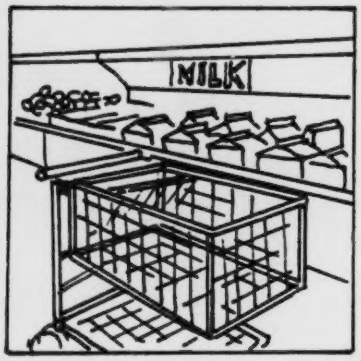
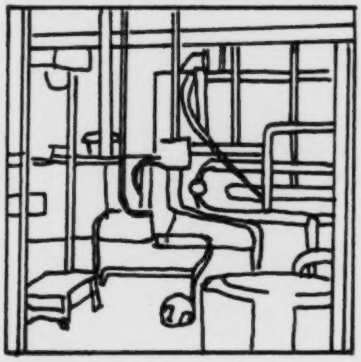
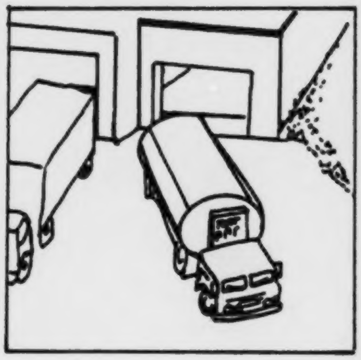
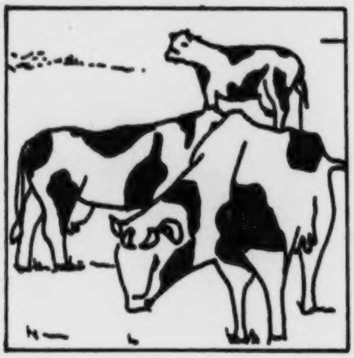










To _______________________ Folks,

We have been talking about HOW ENERGY IS USED IN PRODUCING FOOD. Producing food takes a lot of energy, not just to grow it, but to process and package it, transport it, and prepare it at home. When you eat something different or special at a meal, you could talk to your child about where it comes from and how it gets to your table.

____

5. Question: Where does heat go?

Purpose

To give students the opportunity to observe how heat travels, how warm objects lose heat, and how certain factors can slow heat loss.

Introduction

Students experiment with containers and the classroom itself to observe heat loss. They record their findings and graph the results.

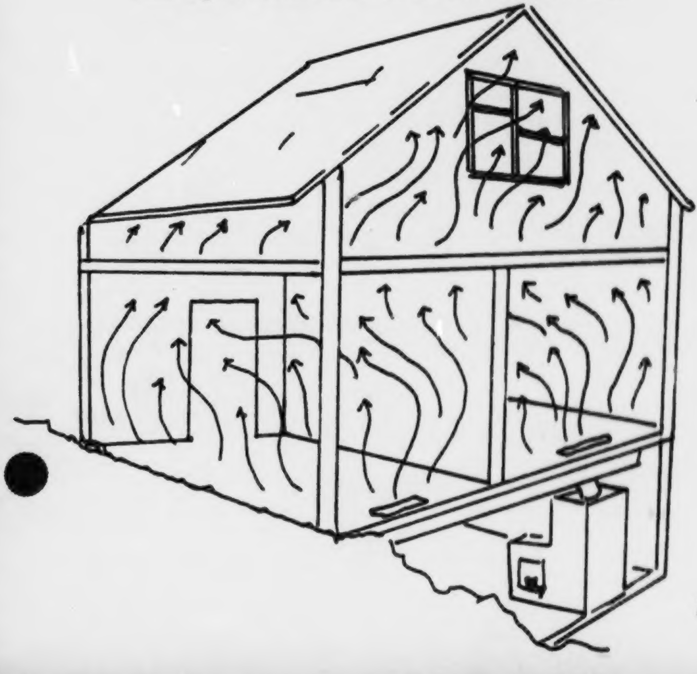
Background

Heat energy travels by conduction, convection, and radiation.

The outside of a glass containing hot water gets hot by the heat traveling through the glass (conduction). We can slow conduction by containing the heat in something that doesn't conduct well (insulation), like styrofoam.

When water is heated in an open pan, it heats the air above it, which expands and rises (convection), being replaced by cooler, denser air. This cool air, in turn, is heated and rises, carrying off more energy. We can reduce convection by blocking air circulation.

Radiation will not be dealt with in this activity except under "More Ideas." Heat, like light, is a form of radiation and can travel through empty space in waves. We can reduce heat loss through radiation by using a "radiant barrier"--some reflective material like aluminum foil.



Understandings

Energy can move from one object to another through materials and through space.

Heat moves through some materials more easily than others.

Skills

Observing
Measuring
Recording data
Inferring
Manipulating materials

Attitudes

Valuing skepticism, careful investigation and logical reasoning as a means of increasing one's understanding.

When builders try to "tighten up" a house or building, they

- insulate and add storm windows, to block conduction
- caulk and weatherstrip around openings, to block convection

Sometimes they use foil-faced insulation, or foil-faced window shades, as barriers to radiation.

Procedure

1. Put equal amounts of hot tap water in three cups: one glass or metal, one styrofoam, and one styrofoam with a lid. Check starting temperatures of all three, and record on the Where does the heat go? sheet. Check and record temperatures after 10, 15, and 20 minutes.

2. Record the data on the board or on a large replica of the work sheet so all children have uniform information.

   Make a line graph of the data using colors corresponding to those on the chart. Children may have had varying experiences with constructing a line graph. For greater success carefully guide them through the process of transferring data from chart to graph.

3. Heat some water to 90°C in a pan on a hot plate. Remove from the heat, let stand for 15 minutes, then record the water temperature. Repeat the process, but put a lid on the pan when it is removed from the heat.

4. Discuss where heat goes.

   Ask: Which cup kept the heat best? Which cup let the most heat get out? Why? Did putting a top on the pan help save heat? How could you get the pan to cool off more quickly? Can heat travel through things? Which things carry heat best? Worst? Can heat travel through air?

5. Have students tape or hang thermometers in different parts of the room, as suggested on the sheet Taking a room's temperature. Leave them in place for a day, recording temperatures at three convenient times. Discuss answers to the questions on the sheet.

6. Review the previous discussion on where heat goes.

   Ask: How do we keep houses warm? Where are some places heat can be lost from a house? What ways do we use to try to prevent heat loss from a house?

Materials

1. glass or metal cup, 2 styrofoam cups (one with lid), 3 thermometers, Where does the heat go? sheets, hot water, crayons or colored felt pens

3. saucepan with lid, hot plate, water, thermometer

5. 6 thermometers, tape, string, Taking a Room's Temperature sheet

Estimated Time for Activity

1.5 hours spread over 1 day

Typical Results

The styrofoam cup with the lid will hold heat the longest. The metal or glass cup will lose heat the fastest. Putting a lid on the pan will slow heat loss. Students will probably find that air near the ceiling of the room is warmer than air near the floor, and that temperatures fluctuate more near the windows.

Safety Notes

1. Make sure tap water isn't scalding, but warmer than room temperature.

3. Hot plate activity should be done as a teacher demonstration, with everyone wearing goggles. Keep hot plate away from any spilled water.

5. Students should be oriented to the use of thermometers: their fragility, possibility of bursting at high temperatures.

More Ideas

"Dead air space" (trapped air that cannot circulate much) is actually a good insulator. Experiment with hot water and various insulations to see which holds heat best. (Those containing many tiny air pockets should work well.)

Reverse step 1 of the procedure. Fill the three cups with equal amounts of cold water. Put them in a pan of water on a low heat. See which one "keeps its cool" the longest.

See whether a "radiant barrier" like aluminum foil helps to keep heat in a cup of hot water.

Where does heat go?

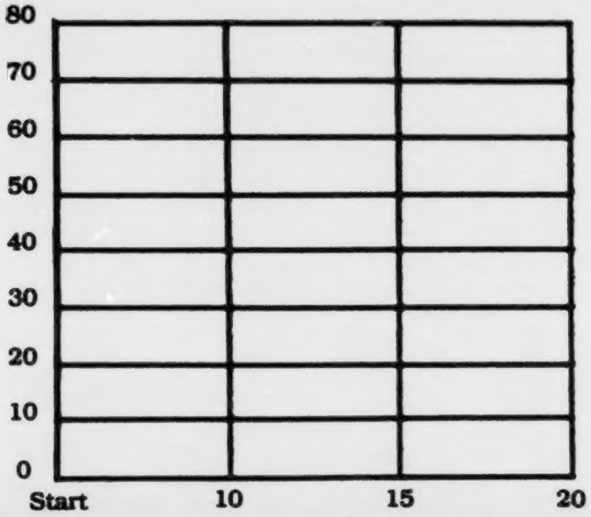
Materials

1 glass, 1 styrofoam cup with no lid, 1 styrofoam cup with lid, thermometers and hot water

1. Fill the 3 cups with hot water.
2. Take the starting temperature of each and write it on your sheet.
3. Put the lid on one cup.
4. Take the temperature again after 10, 15, and 20 minutes. Record the temperatures on your sheet. Put the lid back on the same cup each time.

Color on graph	Type of cup	Starting temperature	Temperature after 10 minutes	Temperature after 15 minutes	Temperature after 20 minutes
○	**Glass or metal**				
○	**Styrofoam without lid**				
○	**Styrofoam with lid**				

5. Choose a crayon or felt pen for each cup.
6. Color the circle next to the name of the cup.
7. Use that color to graph the temperatures for that cup.



Taking a Room's Temperature

Question: How is heat lost?

Materials

6 thermometers, string, and tape

Steps

1. Six places in your classroom are listed below. Put a thermometer in each.

2. Record on the chart the temperature of these places at three different times of the day.

Room Temperature Chart

Place	Time and Temp.		Time and Temp.		Time and Temp.	
Ceiling						
Floor						
Window						
Door						
Inside Wall						
Outside Wall						

What did you find out?

1. Where is the room warmest? ____________________

2. Where is the room coldest? ____________________

3. How do you think heat is moving around the room?

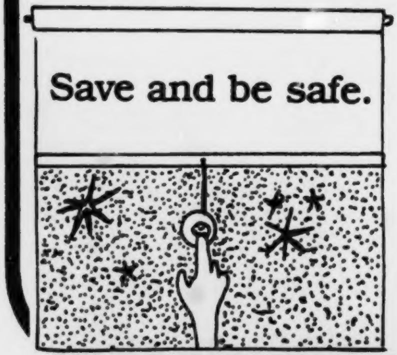
____

4. How do you think heat is getting out of the room?

____

5. How could you keep heat in the classroom?

____


Save and be safe.

**On cold nights,
pull down your shades
to keep the heat in.**

To ________________________ Folks,

Today the class studied the important question "WHERE DOES HEAT GO?" The class found that heat can travel through solids and through the air, but that there are ways to slow down the escape of heat. You might want to talk about how buildings are constructed to keep heat in during cold weather and out during hot weather.

____

6. Question: What is insulation and how does it help us?

Purpose

To have students experiment to discover materials that effectively reduce heat transfer.

Introduction

Students plan and assemble insulated containers in order to preserve ice cubes. Results are compared and effective insulators are discovered.

Background

Conduction is heat transfer through a material. Convection is heat transfer by a moving fluid like air.

Insulation is any material used to slow the transfer of heat. The most important component of most good insulators is trapped air. Air that is moving can carry off heat by convection, but air that is standing still is a poor conductor of heat. Most insulation contains millions of tiny trapped air spaces which slow heat conduction through it.

Insulation is important in both cold and hot climates. It reduces the energy needed to heat homes in cold climates and the energy needed to cool homes in hot climates. Air conditioning costs are often higher than heating costs.

Aluminum foil is often added to commercial insulation to gain an additional energy-saving factor - the reflection of heat energy. Builders and homeowners often put caulk or weatherstripping in places where air can leak in or out, to prevent convection.

Adequate insulation of homes and buildings is an important factor in conserving energy and controlling energy costs.

Understandings

Different materials have different properties.

Energy can move from one object to another. When it does, the properties of the objects may be changed.

Skills

Observing
Predicting
Manipulating materials
Creating models
Recording and interpreting data

Attitudes

Enjoying working with materials.

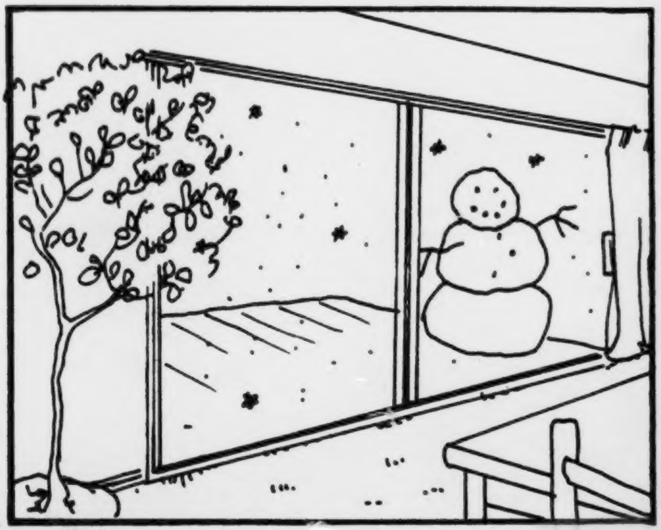
Valuing resourcefulness and innovativeness in solving practical problems.

Procedure

1. Discuss how heat energy always flows from warmer areas to cooler areas.

   Ask: Why do hot things cool off? Why do cold things warm up? How does heat travel? How can we keep heat from escaping? What is insulation?

2. Have students suggest materials they think would help block heat flow. Materials they might suggest are: paper,



cardboard, styrofoam, aluminum foil, newspaper, cloth, foam rubber, dirt, sand, cotton balls, sawdust, plastic containers, juice cans (Fiberglass and rock wool should not be used with children.)

Have students collect items from the list and bring them to school. Teacher may want to provide some of each material so there will be a variety for the activity.

3. Announce a "Save Our Ice Cube" contest. Divide students into groups of 2 or 3. Each group will plan a container made from ONE material they think will save an ice cube from melting.

Each team should record their plans on the Save Our Ice Cube sheets. Provide a washed 1/2 pint milk carton from the lunch program to each team and a plastic baggie with an ice cube. Instruct them to pack their insulating material so that it completely surrounds their ice cube in the container.

Check ice cubes every 15 minutes until all are completely melted. Have teams record their times, and answer the questions on the sheet.

4. Discuss the results and implications of the experiment. Proclaim the winner.

Ask: Why did the ice cubes melt? Which materials slowed down the heat? Which materials were the best insulators? Which results surprised you?

Ask: What ways do we keep things cold at home, at work, traveling, etc.? What kinds of clothes are best in winter? Why do we insulate our homes? In slowing down the escape of heat, what are we saving?

Materials

3. Ice cubes (one per team), plastic baggies, insulation materials and milk containers, Save Our Ice Cube sheets

Estimated Time for Activity

.75 hours plus observation times throughout the day

Activity should be started in the morning.

Typical Results

With some insulation materials ice may take a few hours to melt completely. Materials that contain many tiny trapped air pockets should work best in blocking heat flow.

Safety Notes

2. Fiberglass and rock wool insulation irritates the skin, the eyes, and the lungs. It should not be used with children.

More Ideas

Collect samples of commercial insulation for students to examine.

Ask students to try to find out how their homes or apartments are insulated - where and with what material.

Examine various coolers and thermos type containers to determine their insulation.

Save Our Ice Cube!

Our plan

(Classified; Top Secret)

We have looked over all the materials
we could use to save our ice cube.

We will use ________________________________

____

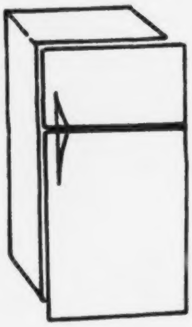
We think it is a good insulator because ______________

____

Time ice cube was placed in container ____________

Time ice cube was completely melted ____________

Our ice cube lasted for ____ hours and ____ minutes.



Save and be safe.

Close the refrigerator!

To ________________________ Folks,

This week the class is studying insulation and how it is used to block the flow of heat from warm areas to cool areas. You can help by talking about how and where insulation is used in buildings to save heat in winter and keep things cool in summer.

Thank you.

____

7. Question: What is static electricity?

Purpose

To allow students to experience and describe several effects caused by static electricity.

Introduction

Students read about static electricity and lightning safety and then experiment with creating static electric charges and observing the effects. (Activities work best when the air is dry.)

Background

A material that transmits electricity easily (like copper) is called a conductor. When electricity flows through such a material we call that an electric current. Many materials don't conduct an electric current well. They are called nonconductors.

With static electricity, electric charges are found near the surface of the material involved (as opposed to current electricity which involves the internal structure of a material). Materials which accumulate static electricity are nonconductors, such as plastic, hair, nylon and glass.

Static electricity may be either positive or negative. If extra electrons are present, the surface will be negative. If there is a shortage of electrons, the surface will be positive. Positive and negative charges attract. If a surface has a certain charge, an object of opposite charge will be attracted to it and an object of the same charge will be repelled by it.

A statically charged object can induce a neutral object to become charged if the two objects are sufficiently close together.

Static charges can accumulate if you rub together two different kinds of non-conductors. It is this process that causes hair and a comb to become charged when you comb your hair. (If the air is moist, static charges "leak" from a surface and the effect is not easily seen.)

Understandings

Different materials have different properties. The interaction of energy and materials may change those properties.

Skills

Manipulating materials
Observing
Inferring
Formulating hypotheses
Recording data
Developing vocabulary
Acquiring information through reading

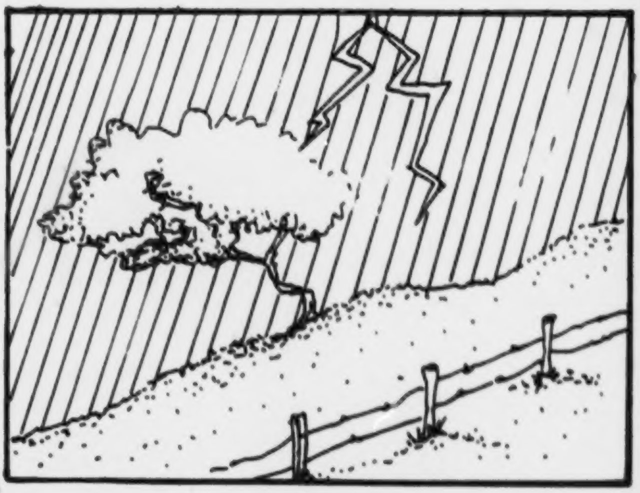
Attitudes

Valuing careful, systematic investigation.

Valuing truthful reporting of findings.

Lightning is a dramatic example of static charges accumulating and then passing from one non-conductor (clouds and air) to another (earth).

Static electricity has some useful purposes. One example is a device that reduces air pollution. Called the "static precipitator", it captures smoke particles produced by burning fossil fuels.



Procedure

1. Ask students if they've ever felt a shock. What do they think it is?
2. Read Snap, Crackle, Pop: Static Electricity.
3. Set up the materials for Experiments A through E at different locations. Have students proceed through the experiments and answer the questions on their sheets: Experiments with Static Electricity. Children can work in small groups and rotate through the stations.
4. Discuss the experiments, the students' observations, and the Lightning Safety questions. Read the lightning safety suggestions.

Materials

2. Snap, Crackle, Pop: Static Electricity sheets
3. Experiments with Static Electricity sheets
    - A. nylon comb, wool cloth, scraps of paper
    - B. nylon comb, wool cloth, water faucet
    - C. nylon stocking, nylon cloth
    - D. nylon cloth, an inflated balloon
    - E. 2 nylon cloths, 2 inflated balloons on strings
4. Lightning Safety sheets

Estimated Time for Activity

1 - 1.5 hours

Typical Results

A. Bits of paper are attracted to the comb.

B. The fine stream of water is deflected by the charged comb.

C. A crackling sound should be heard.

D. The balloon will "stick" to the wall.

E. The balloons will repel each other.

Safety Notes

Caution students about the difference between

1) most static electricity, which is just a tiny, sudden flow of electricity

2) lightning, which is a very large, sudden flow of electricity, and

3) electric household current, which is a large, sustained flow of electricity.

More Ideas

Experiment with other materials to try to produce a static charge -- glass, rubber. Find out what causes the static electricity of lightning.

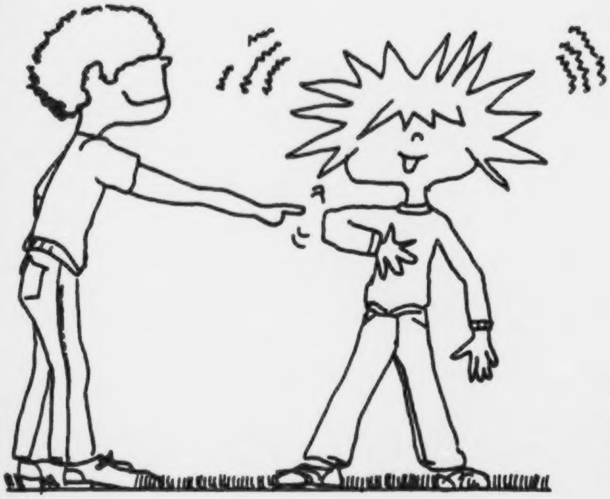
Snap, Crackle, Pop: Static Electricity

Have you noticed how sometimes your hair clings to the comb? Or how it crackles when you brush it?

Do your friends ever give you a shock when they touch you? Sometimes you can even hear a little "snap" as you feel the shock.

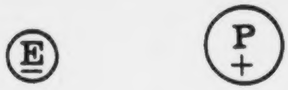
Have you ever watched a thunderstorm? The lightning shoots from the clouds to the earth (or the earth to the clouds) and then the thunder crackles and booms.

The hair clinging to the comb, the shock you feel, the boom of the thunder. These are all signs of a special kind of energy: static electricity.



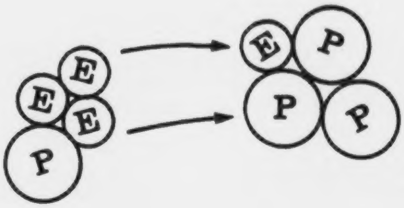
Everything is made of tiny groups of particles. There are many kinds of these particles. Those that cause static electricity are called electrons and protons.

Each of these has a "charge." A charge is a form of energy that can push or pull things, like a magnet does.



Electrons have a minus (-) charge. Protons have a plus (+) charge. Normally there are equal numbers of electrons (-) and protons (+) in an object. But electrons can move. So if something has a lot of extra electrons, that thing has a minus charge. If it has too few electrons, it has a plus (+) charge.

Plusses and minuses attract each other. Why? Because one thing has extra electrons and the other thing needs them.



When they get close, the extra electrons jump from the minus thing to the plus thing. Snap, crackle, pop! You can hear a tiny flow of electricity, like lightning in miniature.

Experiments with Static Electricity

A. 1. Rub the nylon comb with the wool cloth several times.

2. Hold the comb close to the pieces of paper.

What did you observe? ____________________

Did you see energy being used? ____________________

How is this like a magnet? ____________________

B. 1. Turn on the faucet so that a very small stream of water is flowing.

2. Rub the comb with the cloth several times.

3. Bring the comb near the stream of water.

What did you observe? ____________________

Explain what you saw. ____________________

C. 1. Put the stocking over your hand.

2. Rub the nylon cloth and the stocking together several times.

3. Hold your hand (in the stocking) close to your ear, and wiggle your fingers.

What did you observe? ____________________

Can you think of something like this that you have noticed before? ____________________

D. 1. Rub the balloon with the nylon material several times.

2. Place the balloon against the wall, and let go.

What did you observe? ____________________

How is this like Experiment A? ____________________

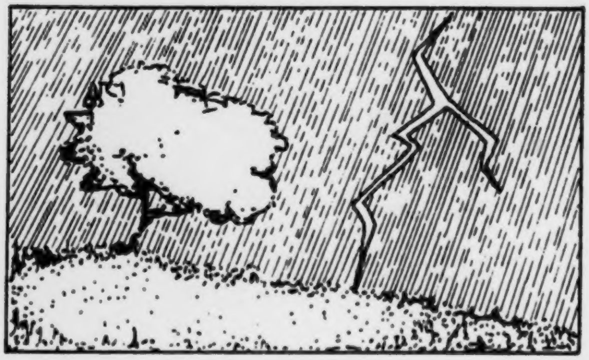
E. 1. Rub both balloons, each one with a different piece of cloth.

2. Hold each string in one hand, and bring your hands together so the two balloons are side by side.

What did you observe? ____________________

Can you explain what happened? ____________________

Lightning Safety



Most static electricity is weak and harmless. But not lightning! Lightning is a huge minus charge, usually jumping from the clouds to the ground. Now that you know something about static electricity, try to answer these questions.

Thought Questions

What kind of damage can lightning do?

Why does lightning often hit the tallest thing in the area--a tree, a utility pole, a tall tower?

Why should you stay out of open areas like lakes and fields when there is lightning?

What do people do to protect their houses and buildings from lightning?

Why does this work?

Lightning Safety Rules

When threatened by lightning:

Don't become a lightning rod.

Immediately move into a house, large building, or an all-metal vehicle. Inside, avoid using the telephone except for emergencies.

If you are caught in a level, open field and your hair stands on end, lightning is about to strike. Drop to your knees and bend forward -putting your hands on your knees. Do not lie flat on the ground.

Don't stick up above the surrounding landscape, by standing on a hilltop, in an open field, or along a beach, or by fishing from a small boat. Get out of and away from open water.

Don't stay near a lightning rod.

Don't stand underneath a natural lightning rod such as an isolated tree in an open field.

Move away from tractors and other metal farm equipment.

Get off and away from motorcycles, scooters, golf carts, and bicycles. Put down golf clubs.

Stay away from wire fences, clotheslines, metal pipes, rails, and other metallic paths.

Avoid standing in a small isolated shed or other small structure in an open area.

If caught in a forest, seek shelter in a low area under a thick growth of small trees. In open areas, find a low place but be alert for flash floods.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, School Information Service, Office of Public Affairs, Washington, DC 20230.

8. Question: How does electrical energy travel?

Purpose

To allow students to learn how a complete electrical circuit works.

Introduction

Students experiment with a bulb and batteries to determine if an electrical circuit is complete or incomplete. Children observe the effects of changing the circuitry.

Background

Electricity is a kind of intermediate form of energy. It is not stored chemical energy, such as wood, batteries, or fossil fuels, and it is not energy in the final form of work or heat.

Electricity is a kind of middleman. Stored chemical energy is converted to electrical energy. Electrical energy then produces heat, light, and motion.

To have electricity you must have a potential difference. In other words, you must have extra electrons (-) but you must also have an area with a shortage of electrons (+) for them to go to. Without a "receiving end", you can't have electric current.

In this activity, a battery is used as the source of electrical energy. Inside the battery, when the terminals are joined by a wire, a chemical reaction takes place creating a potential difference between the battery's two poles. Then the battery produces the electrical current.

Wires carry the electricity to the bulb. In the bulb is a fine wire (filament) which resists the electric current. The resistance causes it to heat up so much that it glows.

Procedure

1. Discuss the properties of electricity.

   Ask: What are some ways we can get electricity? How does electricity travel from one place to another?

Understandings

Energy can move through materials, and be transferred from one object to another.

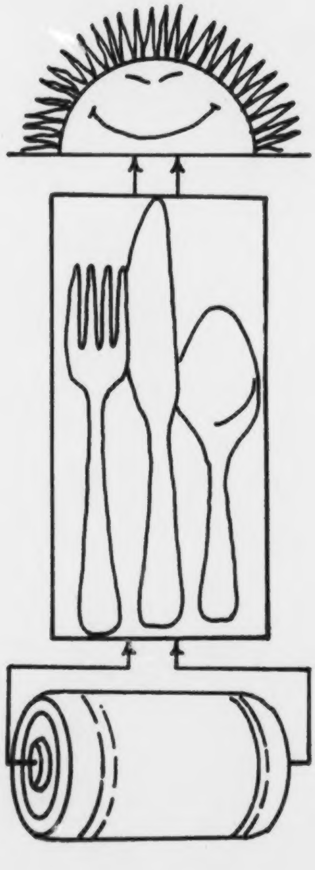
Skills

Observing
Replicating
Manipulating materials
Inferring

Attitudes

Welcoming the unknown or the ambiguous.

Wanting explanations that lead to accurate predictions.



What are some things electricity can do? What forms of energy can electricity be transformed into? (light, heat, mechanical energy, magnetic energy)

2. Following the worksheet, Making a Path for Electrical Energy, set up bulbs and batteries as a demonstration or provide enough materials for children to do the experiments in small groups.

3. Discuss what children discovered about circuits. List necessary components and introduce terminology such as complete circuit, incomplete circuit, conductor.

Materials

2. For each group of students:

2 flashlight batteries, bare copper wire (4 10-centimeter pieces), 2 flashlight bulbs, masking tape, Making a Path for Electrical Energy worksheets

Estimated Time for Activity

0.5 - 1 hour

Typical Results

By number according to the worksheet:

2. The wire should feel warm.
3. The bulb will not light.
4. Nothing should be felt.
5. The bulb lights. This is a complete circuit.
6. Nothing should be felt.
7. The bulb gets brighter.

Try this: Both bulbs are equally bright.

Safety Notes

Make sure batteries are in good condition, not corroded or leaking.

Circuits intended for use with batteries should never be used with household current from an outlet.

Emphasize to students that electricity from an outlet is much more powerful than that from small batteries, and that they should never experiment with outlets, power cords, or appliances. The same goes for larger batteries. They generate enough current to be harmful.

More Ideas

Try using different materials as "wires", to complete the circuit: string, nylon filament, a paper clip.

See Activity 9, which is a natural follow-up to this activity.

Making a Path for Electrical Energy

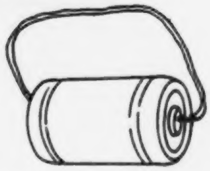
Materials

2 flashlight batteries
2 flashlight bulbs
4 pieces of bare copper wire, each about 10 centimeters long
masking tape

Steps

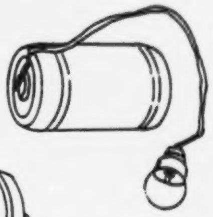
You are going to experiment to see how electrical energy produces light. Use your fingers or the masking tape to connect the wires.

1. Connect one wire to the battery like this.



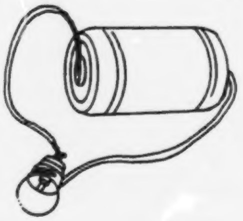
2. Feel the wire.
   Do you feel something happening?
   ____

3. Connect the battery to the bulb like this.
   Did the bulb light?
   ____



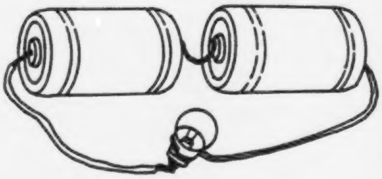
4. Feel the wire.
   Do you feel something happening?
   ____

5. Connect a second wire like this.
   Did the bulb light?
   ____



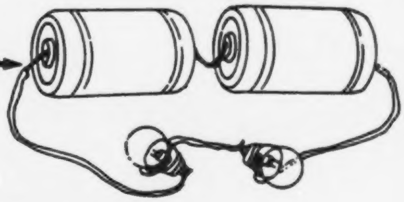
6. Feel the wire.
   Do you feel something happening?
   ____

7. Now connect another battery like this.
   Do you notice anything?
   ____



Try this:

Connect two bulbs to two batteries, like this.



Are both bulbs equally bright?

You have learned that electricity needs a path to travel on. It cannot light a bulb or do any other work unless it has the right kind of path.

Try connecting the batteries and bulbs in other ways. How many ways work?

Save and be safe: **Never experiment with electrical outlets.**

9. Question: What are the best pathways for electricity to travel on?

Purpose

To allow students to discover that some materials conduct electricity and others do not.

Introduction

Students will connect various materials to form a complete circuit. By observation they will determine whether the material tested is a conductor or non-conductor of electricity.

Background

All materials conduct electricity to some extent, but some conduct better than others. The ones that work best--silver, copper, aluminum -- are called conductors.

Materials that conduct electricity the worst are called insulators because they partially block electricity, just as building insulation reduces heat transfer. Good electrical insulators include rubber, glass, and porcelain.

Some materials are neither good conductors nor good insulators; they're somewhere in between.

Whether something conducts well or not has to do with how the atoms of the material are constructed. If the atoms have electrons in an outer orbit, those electrons may be somewhat loosely attached. They can therefore be used in carrying electric current.

Procedure

1. Review Activity 8. Discuss how electricity travels.

   Ask: What kinds of things use electricity to make them work? How does electricity get from the battery or the outlet to the thing it is running? What are power cords made of?

Understandings

Different materials have different properties. Materials vary in their ability to conduct electricity.

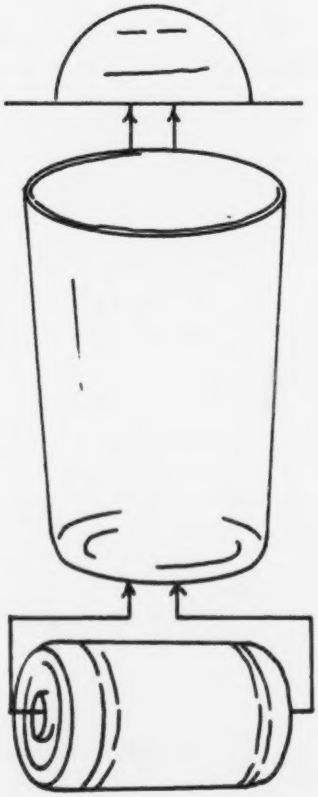
Skills

Observing
Manipulating materials
Inferring
Classifying
Generalizing

Attitudes

Wanting information about the natural world which is accurate and thorough.

Valuing careful, systematic investigation.



2. Have students examine pieces of insulated wire.

   Ask: What is the inside part made of? What is the covering made of?

3. Set up a bulb and battery as shown on the sheet Making a Path for Electricity. Have students experiment with various materials to see whether they will complete a circuit and light the bulb. (This may be done as a demonstration but is more effective if done by the students in small groups. However, students may have difficulty maintaining good contacts with the battery and the bulb. They should be encouraged to check the contacts frequently.)

4. Have students complete their worksheets and discuss their answers. Perhaps generalize types of materials that are conductors.

Materials

2. pieces of insulated wire

3. for each group of children: flashlight bulb, flashlight battery, masking tape, 3 pieces of wire (bare or with the insulation stripped off the ends)

   suggested objects to test: small piece of glass, plastic spoon, penny, nickel, dime, popsicle stick, flashlight battery, cork, paper clip, comb, rubber band, pile of salt, nail, soda can, aluminum foil, ballpoint pen; (students may find other classroom articles to test),

   Making a Path for Electricity sheet

Estimated Time for Activity

0.5 hours

Typical Results

Conductors will include metals (coins, nails, pins, soda cans, paper clips, metal foil) batteries, and salt.

Non-conductors will include rubber, wood, glass, ceramic, and plastic.

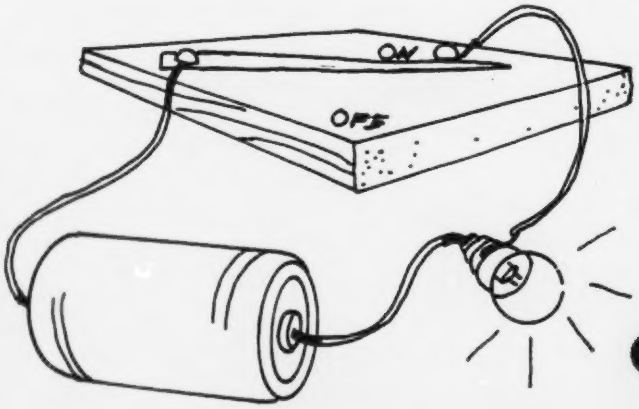
If masking tape is used to make the bulb and battery contacts, these contacts will come loose frequently. Students will need to keep going back to Step 2 on the work sheet to check to see whether their contacts are still good. If you can obtain small porcelain sockets for the bulbs, it will be easier to maintain good contacts.

Safety Notes

Remind students that there is a big difference between the current that comes from a small battery and household current, which comes from a big power plant and can be very dangerous. Larger batteries, like car batteries, are also dangerous.

More Ideas

Use a thin strip of metal nailed to a block of wood to make an ON-OFF switch as shown in the picture below.



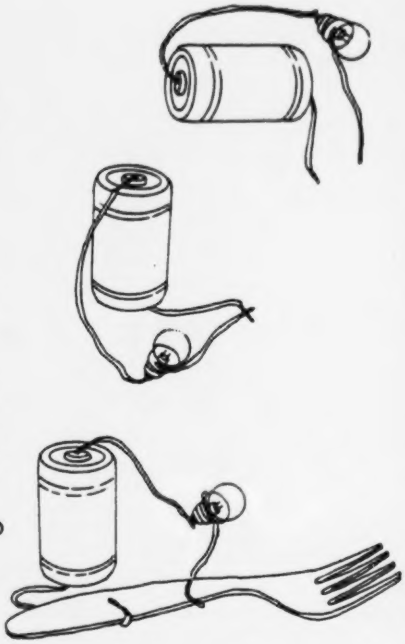
Making a Path for Electricity

Materials

flashlight bulb, flashlight battery, 3 pieces of wire, masking tape

Steps

1. Set up the battery and bulb as shown, with one wire connecting them, and the two other wires only connected at one end. Use masking tape to hold the wire to the right spots.



2. Touch the unconnected metal ends of the two wires to each other.

   Did anything happen? ____________________

   How would you explain this?

   ____

   Keep experimenting with your connections until the bulb lights up. Then you know that you have the wire connected the right way.

3. Collect some small objects that you would like to test as paths for electricity.

4. Make a list of your test objects below.

5. Touch each test object with both unconnected wire ends at the same time. On the table below, record what happens.

(Before and after each test, go back to Step 2 and check your connections to make sure that they are still good.)

Don't experiment with outlets, wires, or appliances. You might become a path for electricity yourself!

Object	Result of test	Is this object a good path for electricity?

Save and be safe

10. Question: How does electricity get to our homes?

Purpose

To enable students to diagram a typical community electrical distribution system from generation to end use.

Introduction

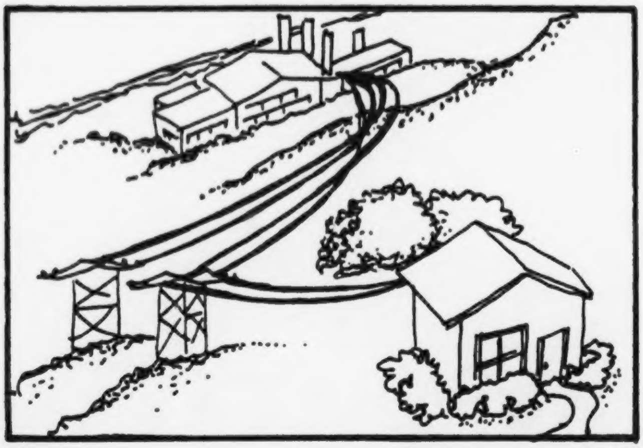
Students observe and read about the steps in the electrical power system. Then they do a sequencing activity that shows their understanding of the system.

Background

Most electricity today comes from steam powered generating plants which burn fossil fuels. Coal, oil, or natural gas is burned to boil water. (In some steam plants, a nuclear reaction heats the water.) The resulting steam spins a turbine, which is like a huge windmill. The spinning turbine turns a large magnet in a generator, which contains many coils of wire. When the magnet turns in the coils, an electric current is created or "induced" in the wires.

Water power can be used instead of steam to turn a turbine. In New York, 15% of the electricity comes from hydropower plants.

Transmission lines carry electricity long distances. Distribution lines branch out to distribute power locally. Substations and transformers regulate the power to the proper levels for use.



10-1

Understandings

Energy can move through materials, and be transferred from one object to another.

Skills

Developing vocabulary
Acquiring information
Using cues
Making decisions
Creating models

Attitudes

Valuing the use of what is known about the natural world.

Valuing the practical and the technological.

The meter "counts" the power being used in a building. If too much power is coming in for safety a fuse will blow (or a circuit breaker will switch off), cutting the path from the outside lines to the outlets in the building.

Procedure

1. Ask: How do we get electricity? How does it get to the outlet in the wall?

   Explain how there are wires in the walls.

   Ask: Where do those wires come from? How does the electricity get into the wires? Let's find out.

2. Take a class walk. Find (with the help of the custodian) the fuse box or circuit breaker box and the electric meter.

   Go outside and see where the wires enter the building. Follow them for a reasonable distance.

   Ask: Where do they go from here? Where does the electricity start?

3. Distribute the two sheets How does electricity get to our homes? and Electricity: from Power Plant to You. Have students read the story and then cut out, arrange, and glue the boxes. It may help the students to look at each drawing and discuss which step it illustrates before they begin the activity. Point out that the story goes step by step from beginning to end. It starts where the electricity is made and it ends at their homes. The underlined words are clues to the correct order of the boxes.

4. Compare the completed worksheets and discuss the process. Some children may be aware of nearby substations or have seen a power plant and can comment.

Materials

2. You will need the cooperation of the school custodian to do this step.

3. copies of the two student sheets, scissors, glue

Estimated Time for Activity

The amount of time required for this activity will vary depending on the time spent on the introduction and the walk. The reading and sequencing may take up to 1 hour.

Typical Results

If students are completely lacking in background knowledge on the subject, they will have a difficult time understanding the concept of electrical generation and transmission. You may wish to do the reading together, diagramming the system on the chalkboard and labeling each part.

Safety Notes

Make students aware that only trained people should handle any part of the electric system, including meters, fuse boxes, and outlets.

More Ideas

Use a state map to find the nearest generating station. Estimate how many miles electricity must travel to get to the school.

Assign children to find the fusebox or circuit breaker box, the electrical meter, the nearest transformer, and where the power line enters the place they live.

Discuss long distance transmission lin -- pros and cons. In some areas electric transmission lines run underground. Discuss the pros and cons of underground cables.

How does electricity get to our home?

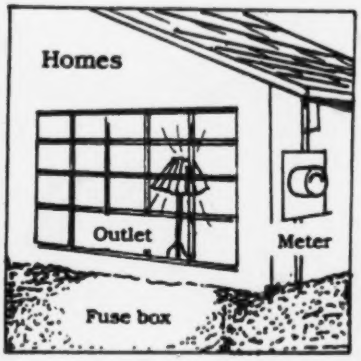
1. Read this story

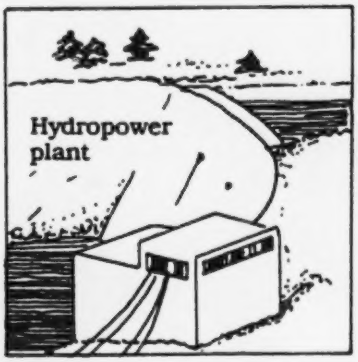
Electricity is made in a power plant. Power plants burn fuel or use water power to make the electricity. A power plant that burns fuel is called a steam power plant. A plant that runs on water power is called a hydropower plant.

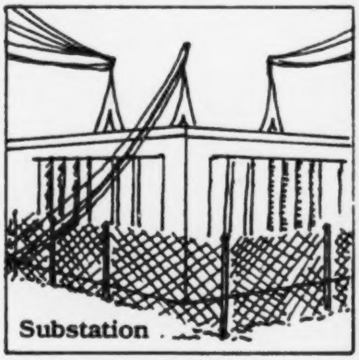
The electricity from the power plant travels for many miles. It travels over long wires called transmission lines. When it gets near to your town it goes through a substation. The substation divides the electricity and sends it over wires called distribution lines.

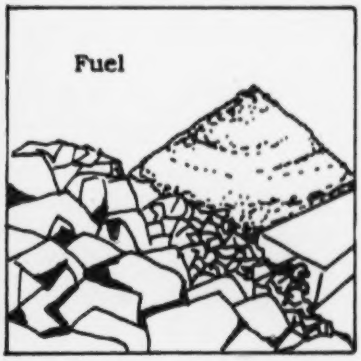
Some of the electricity goes to stores and factories. Some of the electricity goes to your home. Wires go into your home. A meter measures the flow of the electricity, and a fuse box or circuit breaker box controls it. It goes through wires in the walls. The wires go to the outlets. That is how electricity gets to you!

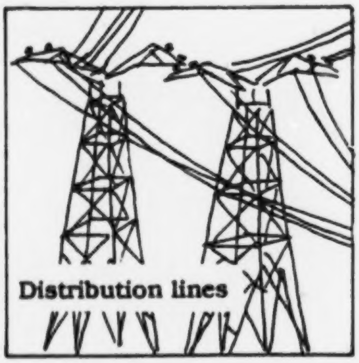
2. Cut out the boxes below.

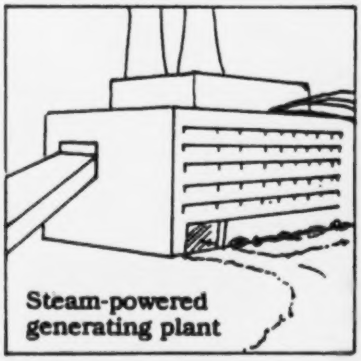

Homes
Outlet
Meter
Fuse box

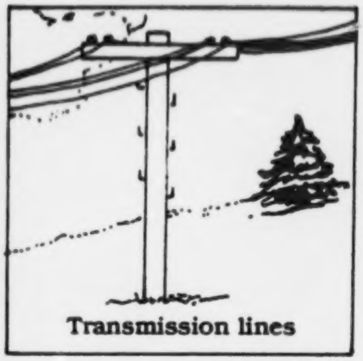

Hydropower plant


Substation

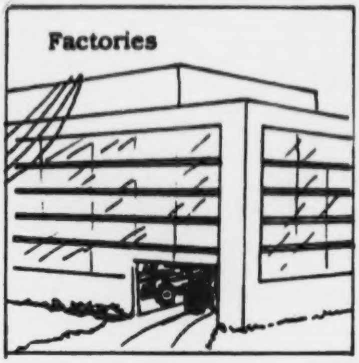



Distribution lines

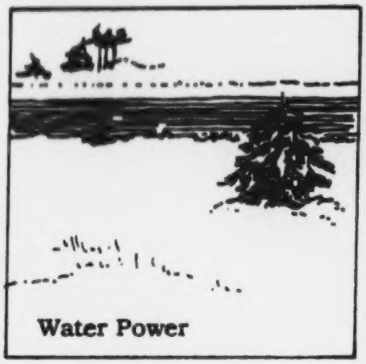

Steam-powered generating plant



Transmission lines



Factories



Water Power

3. Arrange them on the sheet ELECTRICITY FROM POWER PLANT TO YOU.

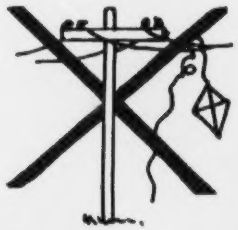
4. Check the pictures with the story above. Make sure the pictures are arranged in the correct order.

5. Glue the pictures on the sheet.

Electricity:

from Power Plant to You

10-5



Save and be safe.

Never play near power lines.

To ______________________ Folks,

Today the class learned HOW ELECTRICITY GETS TO OUR HOMES. You might like to take this opportunity to look together at where and how power gets into your home, and give your child a reminder that power lines are dangerous.

____

11. Question: How can we get energy from matter?

Purpose

To introduce students to the concept that some materials contain energy stored in chemical form, which can be released in different ways.

Introduction

Students use simple household substances to observe the results of burning, fermentation, and decomposition.

Background

We say that food, fuels, batteries, and waste contain energy stored in chemical form. What this means is that certain chemicals in matter, if combined with certain other chemicals, will produce heat, light, movement, or electricity -- and new chemicals. This can happen in several ways.

One way is by burning. When oil burns, the hydrocarbons in oil combine with oxygen; that's why a fire must have air. When this combining takes place, light and heat are produced and a gas (carbon dioxide) is formed. With the food we eat a similar reaction takes place. The oxygen we take into our lungs combines with the food chemicals in our cells to release energy.

Another process is chemical reaction. When vinegar (acetic acid) combines with baking soda (sodium bicarbonate) you get motion (boiling) and gas (carbon dioxide). Carbon dioxide can be used to smother a fire by blocking out the oxygen which the fire needs in order to burn.

Then there is fermentation. When yeast (living plants) absorbs sugar, you get motion (rising), heat, gas (carbon dioxide), and chemical energy stored in a new combination called ATP.

With decomposition, the combinations of chemicals in once-living material break down into simpler combinations. Methane gas and heat are generated during this process of decay.

Understandings

Energy can be changed in form by interactions with materials. The properties of the materials may also be changed.

Skills

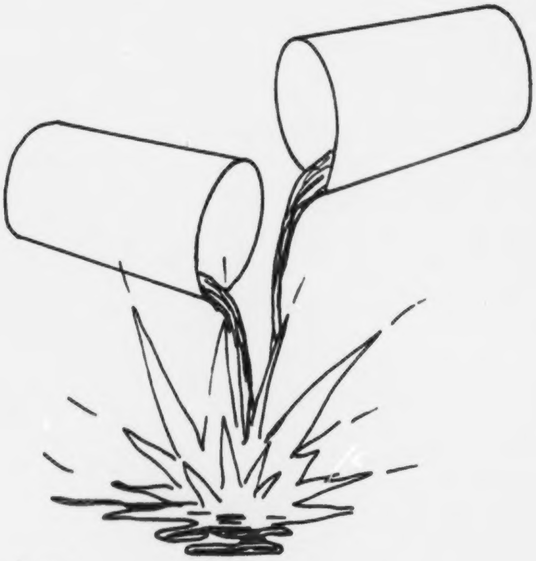
- Measuring
- Manipulating materials
- Observing
- Recording data
- Interpreting data
- Formulating hypotheses

Attitudes

Wanting explanations which clarify.

Welcoming the unknown.

Valuing careful, systematic investigation



Procedure

1. Ask: What is matter?

   Discuss what the word might mean. Explain that matter is anything that takes up space and has weight - a solid, a liquid, or a gas. Give examples: a glass of apple juice, air, a cup of vegetable oil, a pile of leaves

   Ask: Can we get energy from matter? How can we do this?

2. Ask: What happens when you have fire? What must you have for a fire? Do you need something else besides fuel? (air, oxygen) What does a fire make? Does it give us energy? What kinds? Do some things make better fuels than others? What are good fuels?

   Do the experiment Getting Energy from Burning. (You may wish to do this as a demonstration, since it involves fire.)

3. Ask: Do you have to have a fire to get energy from matter? Can you get energy by mixing things? Drop an Alka-Seltzer tablet in a glass of water. Ask: Is this giving off energy? Why? What else do you think is happening? What are the bubbles? What is a chemical?

   Do the experiment Getting Energy from Chemicals. (Again, this involves an open flame, so you may wish to do it partially as a demonstration.)

4. Explain that there are many different chemicals in matter, and many different kinds of chemical reactions.

   Do the experiment Getting Energy from Fermentation. Students can do this in small groups. Discuss the small groups' results.

   Then do the Yeast + Sugar = ? experiment. Let it stand for several hours and allow students to observe and record their observations through the day. Discuss their observations.

5. Review the first four experiments.

   Ask: What happened when we burned the oil? Did we get heat energy? What do you think happened to the oil and the rope we burned? Did they change to something else? What happened when we mixed the baking soda and vinegar? Did it release energy? What else did it release? Did the yeast and apple juice experiment release energy? How did we know? What did we get from the yeast and sugar? How did we know?

6. Explain that matter sometimes changes very slowly, over weeks, months, or years. As it changes, it may give off energy, or it may store energy in different forms (such as gas). Explain that you are going to do a long, slow experiment to see if you can get energy from matter as it decays.

   Introduce the experiment Getting Energy from Decomposition. Do the experiment as a class project and appoint teams to observe and report on the composter each week.

Materials

2. vegetable oil, #20 or 30 motor oil, cotton clothes line, glass eyedropper, thermometer, matches, tin can, paper clips, metric measuring cup, styrofoam cup, wire coat hanger or ring stand, Getting Energy from Burning worksheet

3. glass of water, Alka-Seltzer tablet, baking soda, vinegar, quart-size bottle with small mouth, candle, matches, Getting Energy from Chemicals worksheet

4. styrofoam cups, thermometers, yeast, apple juice, water, Getting Energy from Fermentation worksheet

   plastic bowl with lid, warm water, sugar, yeast, masking tape, plastic tubing, modeling clay, glass of water, Yeast + Sugar = ? worksheet

6. large container, various organic wastes, soil, shovel, earthworms (if possible), Getting Energy from Decomposition worksheet

Estimated Time for Activity

1.5 hours for the introductory discussion, the first four experiments, and the review

1 hour to set up the composter, plus brief times for observation over several weeks

Typical Results

The motor oil should produce more of a temperature change when burned. The baking soda and vinegar will foam up, and the carbon dioxide gas will extinguish the candle.

The yeast with apple juice will produce a measurable change in temperature (about 8°C in 30 minutes). The yeast in water will not.

In the yeast and sugar experiment, the lid will bulge out from the gas pressure. If a tube is used, gas bubbles will begin to come from the tube and rise to the surface of the water. Bubbling will become more rapid, then slow down and stop.

The composter will begin to smell of methane gas after several days. The center of the compost should also heat up noticeably.

Safety Notes

2. & 3. Students should wear goggles when observing these experiments

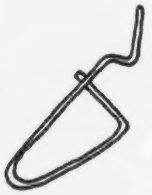
6. Don't use meat or bones, dairy products, baked goods, or fruit wastes in the composter, as these may attract vermin. To avoid spilling, it is best to use a lid that fastens.

Getting Energy from Burning

When you combine some materials with oxygen from the air, you get burning and heat. Some materials make more heat because they contain more stored energy. Which do you think has more stored energy - vegetable oil or motor oil?

Materials

- vegetable oil
- #20 or #30 motor oil
- 2 pieces of cotton clothesline, 3 cm each
- glass eyedropper
- thermometer
- matches
- tin can
- paper clips
- metric measuring cup
- styrofoam cup
- wire coat hanger or ring stand
- masking tape

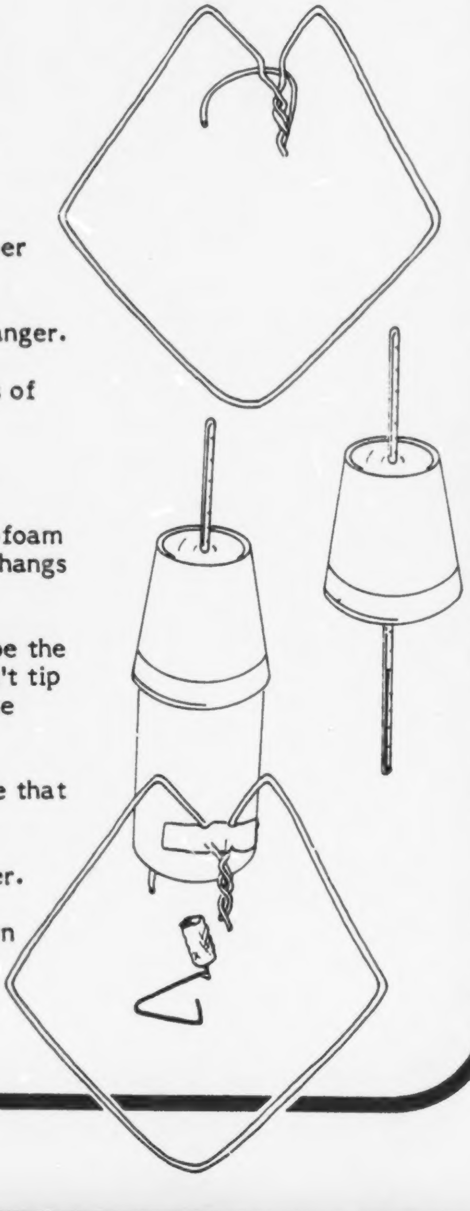


Steps

1. Make a spike for the clothesline out of a paper clip.
2. Make a stand for the tin can out of a coat hanger.
3. Saturate a piece of clothesline with 20 drops of vegetable oil from the eyedropper.
4. Put 100 milliliters of cold water in the can.
5. Make a small hole in the bottom of the styrofoam cup and push the thermometer through so it hangs from the cup.
6. Set up the experiment as in the picture. Tape the can to the coat hanger stand so that it doesn't tip or fall off. The thermometer should be in the water but not touching the can.

   CAUTION - Do your experiment on a surface that won't burn!

7. Record the starting temperature of the water.
8. Light the oil on the clothesline and let it burn completely.



9. Record the water temperature after the clothesline burns out completely.

10. Repeat the whole experiment using fresh water, a fresh piece of clothesline and the motor oil.

Oil tested	Temperature of cold water	Temperature after burning	Difference in temperature
Vegetable oil			
Motor oil			

Which do you think has more energy - the vegetable oil or the motor oil?

____

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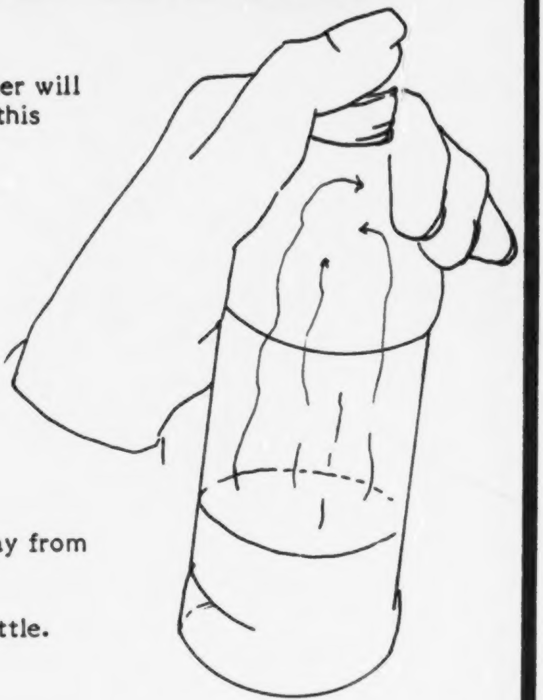
Getting Energy from Chemicals



Sometimes just putting chemicals together will release energy and make new chemicals. Try this chemical reaction.

Materials

baking soda
vinegar
quart-size bottle with a small mouth
candle and matches

Steps

1. Place the candle in a sink or dishpan, away from anything that could catch fire.
2. Put a tablespoon of baking soda in the bottle.
3. Light the candle.
4. Pour a few milliliters of vinegar into the bottle and cover the mouth with your hand.

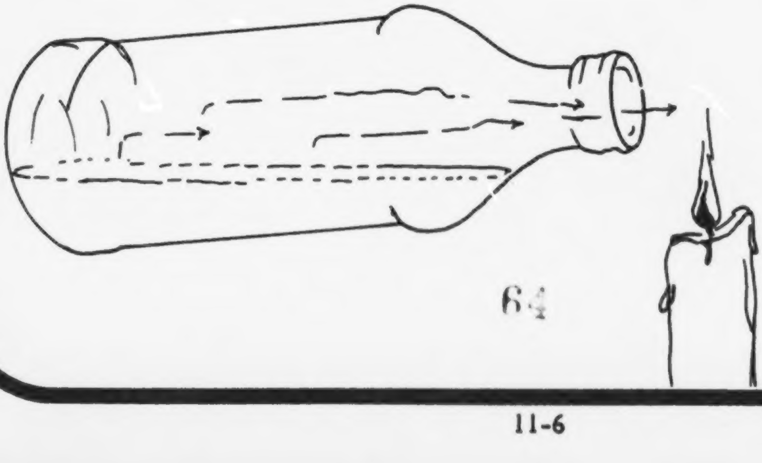
   What do you feel? ______________________________

5. Hold the bottle tipped so the mouth is slightly above the candle flame. Don't spill the liquid.

   What happens? ______________________________

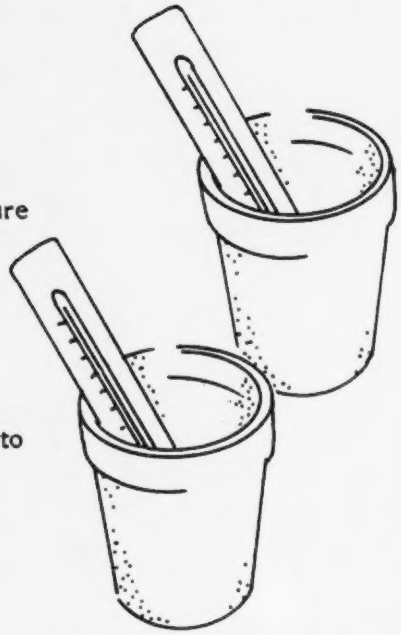
   Why do you think this happened? ______________________________

   What must fire have in order to burn? ______________________________



Getting Energy from Fermentation

Some materials ferment when you put them together. When a mixture ferments, several things happen.



Materials

2 styrofoam cups
2 thermometers
4 packages of yeast (1 ounce each)
20 milliliters of apple juice at room temperature
20 milliliters of water at room temperature
stirrers

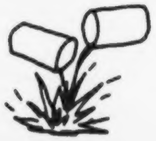
Steps

1. Pour 2 packages of yeast into each cup.
2. Add the apple juice to one cup, and the water to the other.
3. Stir both mixtures well.
4. Place a thermometer in each cup.
5. Record the starting temperature.
6. Record the temperature of each thermometer after 10, 20, and 30 minutes.

Starting temperature	Temperature after 10 minutes	Temperature after 20 minutes	Temperature after 30 minutes
Cup with apple juice			
Cup with water			

What did you observe? ______________________________

What do you think caused this? ______________________________



Save and be safe.

Some chemicals should never be mixed.

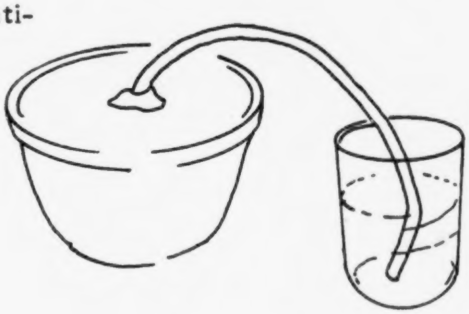
Don't experiment on your own.

More Fermentation: Yeast + Sugar = ?

Materials

plastic bowl with a lid (1 quart or larger)
2 cups of warm water
1 tablespoon of sugar
1 package of yeast (1 ounce)
masking tape

If possible: some plastic tubing (30-40 centimeters)
modeling clay
a scissors
a glass of water



Steps

Morning

1. Put the warm water in the bowl.
2. Add the sugar and yeast and stir.
3. Put the lid on and tape it if it isn't tight.

If you have the tubing:

4. Punch a small hole in the lid.
5. Insert the tube so that it is above the water level.
6. Pack clay around the tube so that no air can escape.
7. Put the other end of the tube in the glass of water.

Afternoon

1. After the bowl has been sitting for a while, what do you observe? ____________________ ____________________
2. Draw what you see. ⟶
3. What may have caused this? ____________________
4. What kind of energy is being produced? ____________________
5. What else is being produced? ____________________

Getting Energy from Decomposition

When plant and animal wastes decay, they change. In the changing, they may give off energy, or store it in new forms.

Materials

a large container with a tight lid (wooden box, plastic garbage can, etc.)
vegetable scraps, grass clippings, wood ashes, soil, manure, leaves, weeds
shovel
earthworms (if you can get them)

Steps

11-9

1. Set up your composter outside your classroom window. Fill the container with many layers of waste.
2. Put a layer of soil on top to keep down the smell.
3. Add earthworms if you can get them.
4. Once a week make a hole in the middle of the compost and insert a thermometer. Record the temperature. Then add a little water, stir the compost with the shovel, and add a layer of soil on top.

What did you observe over the time you were checking the composter?

1. About the temperature?
2. About the smell?
3. What do you think caused the temperature change?
4. What do you think the smell was?

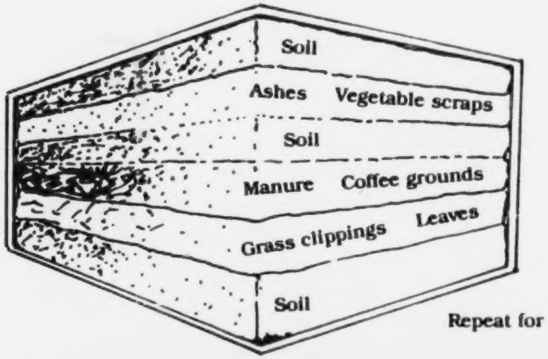


Diagram of Your Composter

Repeat for many layers.

Temperature Record for Your Composter

Starting temperature	Outside the composter	Inside the composter
End of week 1		
2		
3		
4		
5		
6		
7		
8		

12. Question: What are the different kinds of batteries, and which are best?

Purpose

To show students through an experiment and a computer program that the value of energy products cannot be determined by considering price alone.

Introduction

Students will calculate the operating cost (by their own experimentation or by using a computer program) of 3 types of batteries. By calculating expense in terms of operating life students will determine which battery is the best economic value.

Background

Batteries are a part of almost every person's life. The decision as to which kind to buy is usually made for varying reasons i.e. advertising, price, availability, convenience of use. With a little information the decision might become easier to make.

Household batteries come in three general types: zinc-carbon, alkaline, and rechargeable nickel-cadmium. They all work on the same principle but have different "lifetimes".

A battery is a container in which a chemical change takes place. When the battery is part of a complete electric circuit, electrons activated by the chemical change can do useful work as they pass through the circuit.

In zinc-carbon and alkaline batteries the chemical change that produces the current of electrons is non-reversible. So these batteries have definite shelf lives because the chemical change continues very slowly, even when the battery is not in use. Eventually it will stop. If the battery is in use the reaction occurs more rapidly and will stop more quickly.

In a nickel-cadmium or other rechargeable battery the reaction is reversible. By applying an electrical current the reaction that exhausts the battery is reversed. The electron-producing reaction can then happen over and over.

Understandings

The amount of energy available from a source can vary.

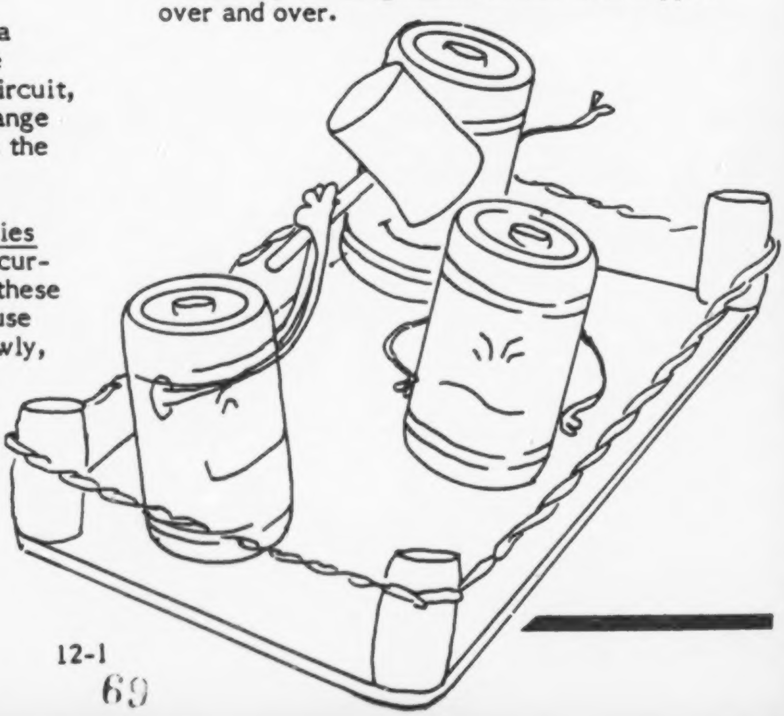
Skills

Observing
Recording data
Using numbers
Interpreting data
Generalizing

Attitudes

Valuing logical reasoning.

Valuing the practical and the technological.



Procedure

To do this activity, students must know

A. that there are three types of batteries
B. that they are called alkaline ("A" in the program), zinc-carbon ("Z") and nickel-cadmium rechargeable ("N")
C. the cost of each type of battery
D. the average life of each type of battery. You must give students the cost information. You may get the average life information by experimentation (see methods A and B below) or you may simply use the information built into the computer program (method C).

There are three options for presenting this lesson.

Method A.

Provide 3 identical toys, each powered by one of the three types of batteries explained in the "Background" information. Test the toys as a class demonstration, and use the worksheets to do the calculation. Use the program to check the work.

Method B.

Test each of the 3 types of batteries successively in the same toy. When one runs down record its life time and repeat the demonstration with the second type of battery, then the third. Use the worksheets to do the calculations, and the program to check the work.

Method C.

Simply show the three types of batteries without doing any demonstration, and use the average life data supplied in the program instead of collecting your own data. Then students only need to know the cost of each type of battery. The average life data used in the program are:

Battery Type	Average Life in Minutes
alkaline (A)	180
zinc-carbon (Z)	60
nickel-cadmium rechargeable	60,000 (assumes 1,000 charges)

1. Introduce the activity by discussing the difference between rechargeable and non-rechargeable batteries.

2. Carry out the activity following one of the methods described above.

3. Follow the work on the student sheets with a discussion. Suggest that students take the information home and discuss with their families. Make sure the point is made that initial cost is not the only factor to consider when making a purchase.

Materials

Method A.

three types of batteries, three identical battery-powered toys, Battle of the Batteries and Dollars and Sense worksheets, Battling Batteries computer program, Commodore 64 microcomputer

Method B.

one battery powered toy (instead of 3), plus other materials listed for Method A.

Method C.

three types of batteries, BATTLING BATTERIES computer program, Commodore 64 microcomputer

Estimated Time for Activity

Method A = up to 2 hours running time, 1 hour for discussion, worksheets, and computer checking
Method B = up to 4 hours running time, 1 hour for discussion, worksheets, and computer checking

Method C = 0.5 hours for discussion and computer work

Typical Results

Working with the program alone will make the point (and save money), but students become more involved if they collect their own data (Methods A or B).

Safety Notes

Make sure that students know how to operate the toys safely.

Warn students that only rechargeable batteries should be recharged. Other batteries may explode in a charger.

More Ideas

Investigate other types of batteries, their costs and uses. Find out how to make a simple battery from a physical science book. Find out whether desposable batteries contain toxic substances. Is this a problem?

Add the cost of the battery charger to the cost for rechargeable nickel-cadmium batteries. Find out how much of a difference it makes.

The Battle of the Batteries

Materials

3 identical battery powered toys
new batteries: alkaline, zinc-carbon, nickel-cadmium rechargeable, fully charged
masking tape

Steps

1. Put one battery in each toy. Put a piece of tape on each toy and label it with the type of battery it contains (A, Z, or N).
2. Start all three toys at once. Record the starting time.
3. Run each toy until it stops. Record the stopping time.

Name of toy ______________________________

Type of battery	Starting time	Stopping time	Total running time hours	minutes
Alkaline				
Zinc-carbon				
Nickel-cadmium rechargeable				

Which battery lasted the longest? ______________________________

Which had the shortest life? ______________________________

What other things might have affected your results?

____

To make sure your results are right, what could you do?

____

Dollars and Sense

In the BATTLE OF THE BATTERIES, which battery had the longest life?

Which battery really lasts the longest? Why? ____________________

____

Look at the table below. Ask your teacher for the price of each battery.

Which battery costs the most? ____________________

Manufacturers claim that rechargeable batteries can be reused 1,000 times. Let's see how the costs per minute of the three kinds of batteries compare.

Fill in the running time for each battery from your BATTLE OF THE BATTERIES sheet.

Now figure out the cost per minute.

	Cost	÷	Total running time hours	minutes	=	Cost per minute
Alkaline		÷			=	
Zinc-carbon		÷			=	
Nickel-cadmium rechargeable		÷		X 1000 recharges	=	

(Hint: change your dollars to pennies and your hours to minutes) Compare the cost of each battery. Which is the cheapest to buy?

____

Compare the cost per minute of each battery. Which is the cheapest in the long run?

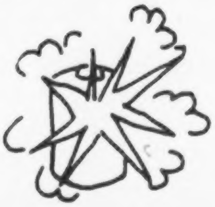
____

Think of reasons why you might buy each one. Write down your reasons.

____

Save and be safe. ____________________

____



Never try to recharge a non-rechargeable battery.

13. Question: Will we run out of energy? Can we conserve it?

Purpose

To introduce students to the principles of energy conservation.

Introduction

Using peanuts to represent a limited supply of resources, students will model options that are available as to the distribution of the resources. They will then discuss how people can prolong the availability of those energy resources.

Background

Energy is never "lost", but it does change from more useful forms to less useful forms. Some sources of energy will be with us for as long as the earth lasts: renewable energy sources like the sun and the wind. Others exist in limited supply : nonrenewable energy sources like oil, coal, and uranium.

We generally burn fuels, so their stored chemical energy is changed to heat. That heat gradually dissipates into the universe, not lost but no longer useful.

Therefore, although we'll never run out of energy, we may run out of certain kinds of energy that we have found very useful and have come to depend on.

What's more, in changing the form of a fuel we often produce undesirable byproducts and effects. Examples are radioactive wastes from fissioning uranium 235, sulfur dioxide from burning oil and coal, and smoke particles from burning wood and refuse.

Energy conservation does not merely mean making do with less. It means making intelligent and well informed decisions about the best ways to use each kind of energy. Most energy experts agree that with good energy planning there need not be any "energy crisis."

Understandings

The energy available from some sources is limited.

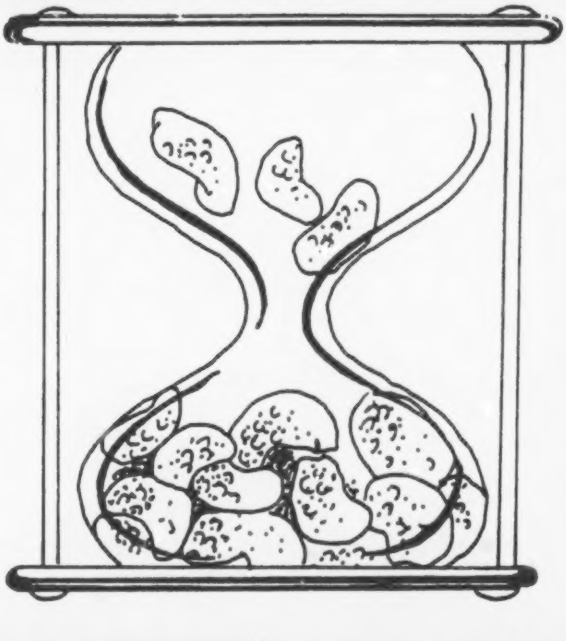
Skills

Using numbers
Creating models
Acquiring information
Generalizing
Communicating attitudes

Attitudes

Respecting the rights of others in using resources.

Caring about the needs and problems of others.



Procedure

1. Prepare a covered box or bag with three times as many peanuts as you have students. Students should be able to reach in without seeing in.

2. Explain to students that you have put an unknown number of peanuts into this box. Emphasize that you would like to share them with everyone in the classroom. Walk around the classroom

allowing each student to take as many peanuts as they like. The students may not eat the peanuts until everyone has them. The students who are last will most likely not have peanuts to take or they will have fewer than the other students.

3. Ask some/all of the following questions:

    1) Are you happy with the number of peanuts you have? Why?

    2) Is it fair that some of us have 5 or 6 and others have none? Why?

    3) Do you think the first people to take peanuts were out to gyp those who were last?

    4) Were they wrong to take a big handful? (It's important to remind them that the first people didn't know how many peanuts were in the box.)

    5) Knowing there is a limited supply of peanuts would they distribute the peanuts differently?

4. Redistribute the peanuts so that everyone has an equal share to eat. Introduce the students (while they eat their peanuts) to the idea of the peanuts representing one of our non-renewable energy resources such as oil, coal, minerals, etc. There is a limited amount of each of these resources in the ground.

    Ask: What can we do to slow the consumption of our resources?

    a. conservation
    b. renewable energy sources
    c. new inventions

5. Use the Make the peanuts last! sheet with students to figure out the effects of conservation on resources, Students can resort the peanuts manually each time, or figure out mathematically the number of piles there would be by dividing the total number of peanuts by the number it takes to get a certain temperature.

6. Close the activity with a general discussion of the results of the activity.

    Ask: Does this same idea hold true for transportation, too? Can we use less and make it last longer? What is the point of saving if we are going to run out someday anyhow? Suppose we really didn't have enough peanuts (or other food) to feed everyone. Could we get more? How? Is the same thing true for oil? Why or why not? Are there other kinds of energy that we can always get more of? What are they? What can we do to become less dependent on fuels like oil? What is energy planning?

Materials

1. covered box or bag, peanuts

5. Make the peanuts last! sheet, a fresh supply of peanuts (50 or so)

Estimated Time for Activity

0.5 hours

Typical Results

This is a highly teacher-directed activity, and what the students learn from it will depend to a large extent on how the teacher handles the discussion. The goal should be to leave students with the sense that energy planning is possible and that conservation is a creative challenge, not a depressing bore!

Safety Notes

None

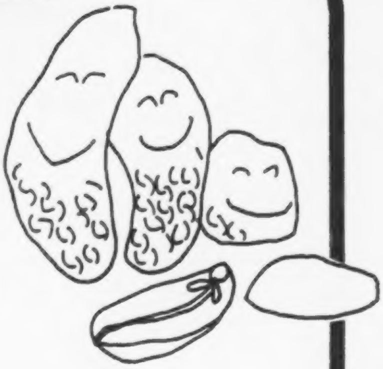
More Ideas

Have students do the mathematics of figuring out how many miles a given car will be able to travel on a given amount of gasoline. Compare different cars with different mpg's.

Explore the environmental effects of using different kinds of energy. Make a chart that compares energy sources as to whether each one is:

abundant or scarce
renewable or nonrenewable
convenient or inconvenient
polluting or nonpolluting
affordable or expensive

Make the peanuts last!



To heat my home to 75 degrees for a day, it takes 5 peanuts.

To heat my home to 70 degrees for a day, it takes 4 peanuts.

To heat my home to 65 degrees for a day, it takes 3 peanuts.

To heat my home to 60 degrees for a day, it takes 2 peanuts.

How many days will I be able to heat my house with the box of peanuts, at the following temperatures?

Let's find out.

1. Take the peanuts from the box. Put them in piles of 5.
2. Count the number of piles and record that number on the chart below.
3. Repeat steps 1 & 2, making piles of 4 peanuts, and count the number of piles. Then make piles of 3 peanuts each, and count the piles. Finally, make piles of 2 peanuts each, and count the piles. Each time, record the number below.

Peanuts to a pile	**Number of piles**	
		1. I can heat my house at 75° for _____ days.
		2. I can heat my house at 70° for _____ days.
		3. I can heat my house at 65° for _____ days.
		4. I can heat my house at 60° for _____ days.

Questions

5. At which temperature will I be able to heat my house for the greatest number of days? ______________________________
6. What do the peanuts represent in this activity? ______________________________
7. Will our "peanuts" last forever? ______________________________
8. Can you think of ways to make the "peanuts" last longer? What are the ways? ______________________________

____

Glossary

a

acid: a sour tasting substance that can break down other materials, and that turns blue litmus paper red. Most acid found in rain and snow is caused by burning fossil fuels.

acid deposition: the depositing of acid in the environment in snow, hail, sleet, fog, dew, frost, or dry sediment. The acid is the result of air pollution.

air: the mixture of gases that surrounds the earth. Air is odorless, tasteless, and colorless. It contains oxygen and carbon dioxide, which are used by living things.

alcohol fuel: fuel made by distilling grain, wood, or other plant products into alcohol.

alkaline battery: a dry cell battery that uses a highly alkaline (basic) electrolyte and gives a high charge for a relatively long period of time.

ampere: the unit of measurement of the rate of flow of an electric current (number of electrons/second).

appliances: machines, especially household machines, that use energy (usually electricity) to do work.

armature: a part of an electric motor or generator that revolves between the poles of a magnet (or within which a magnet revolves). It is made of wire wound around an iron core.

b

base: a substance that feels soapy when mixed with water, and that turns red litmus paper blue (also called alkali).

battery: a container holding wet or dry electrolytes that produce electricity.

biomass: an amount or volume of plant material in any form: algae, wood, crop residue, animal manure, etc. Biomass contains energy stored in chemical form.

c

caulking: a soft material that can be squeezed into the cracks of a building, to reduce the flow of air into and out of the building.

chemical energy: the energy released when substances combine or break down and form new substances.

chemical reaction: the combining or breaking down of substances to form new substances. Energy is used or given off in the reaction.

circuit: an arrangement of wires, tubes, etc., through which electricity flows.

clouds: masses of tiny drops of water or ice particles floating in the air high above the earth.

coal: a fossil fuel; a black rock composed mostly of carbon, formed under the earth's surface over millions of years from the remains of plants. Used as a fuel because it burns easily, coal causes air pollution when burned. It is a non-renewable energy source due to the conditions and time necessary to form it.

cold: having little heat energy.

conduction: the process by which heat or electrical energy travels through substances.

convection: the process by which heat energy travels in currents of air, water, or other fluids.

current: flow of electricity through a wire. The rate of flow is measured in amperes.

d

dam: a wall built to hold back flowing water. A dam may be part of a hydropowered generating plant.

decay: to rot or become rotten; to break down.

decomposition: rotting and breaking down of substances into what they are made of.

distance: the space between objects, or the space an object travels in a certain length of time.

distribution lines: heavy-duty wires that are used to distribute electricity from substations to nearby energy customers.

dry cell battery: a battery with the electrolyte in a paste form to reduce the risk of leaks.

e

electric current: a flow of electricity through a wire that can be measured, and is used to operate appliances, lights, etc.

electrical system (car): the system of devices and wires that produces and distributes electrical energy in a motor vehicle. Includes an electrical generator and a storage battery.

electricity: a form of energy that can produce light, heat, motion, and magnetic force. Electricity is a flow of electrons that can be produced by generators, friction, or chemical change in a battery.

electrolyte: a chemical (compound) which when dissolved in water will conduct an electrical current.

energy: the ability to do work. Light, heat, electricity, and gravity are some forms of energy.

engine (car): a machine that burns fuel to convert its chemical energy into mechanical energy.

exhaust system (car): a series of connected pipes that helps remove the waste products of an automobile engine.

f

force: any push or pull on an object.

fossil fuels: non-renewable energy sources (coal, petroleum, and natural gas) that must be mined or pumped from the ground and then burned to release their energy. A large share of our energy comes from fossil fuels; however, mining and burning them cause pollution and damage the earth's surface. These fuels are formed from the fossilized remains of plants and animals that have been buried for millions of years.

friction: a rubbing of one thing against another. The force that results when two moving objects are in contact with each other.

fuel: something that can be burned or broken down to produce heat energy.

fuse box: a small metal box connected to the main electrical circuit in a building. It contains fuses which are small metal strips inserted into an electrical circuit that melt and break the connection when the current becomes too strong.

g

gas turbine: a turbine that produces electricity by using the force of hot, expanding gases to make it revolve. The gases are produced by burning a fuel.

generator: a machine that changes energy of motion (mechanical) into electrical energy. It consists of a magnet and a coil of wire.

geothermal energy: the heat energy in the rocks, hot water, and steam in the earth's crust.

h

head (water power): the height that water from behind a dams falls to reach the turbine.

heat: the energy given off when the molecules of a substance move.

home: a place where a person or family lives. A home may be an apartment, a house, a mobile home, etc.

hot: having much heat energy.

hydropowered generating plant: a building or dam that contains machines that use the energy from falling water to make electricity.

i

ice: water made solid by cold; frozen water.

insulation: a material that slows heat loss or waste. Fiberglass, cellulose, rockwool, and styrofoam are examples.

j

joule: a metric unit of energy, equal to the energy used in one second by an electric current of one ampere, with a resistance of one ohm.

k

kilowatt: a measure of electric power, equal to 1000 watts, or to energy consumption at a rate of 1000 joules per second.

kilowatt hour: amount of energy equal to one kilowatt of power being used for one hour.

l

light: a form of energy that animals use to see and that plants use to make food. When light is absorbed by objects they heat up.

m

magnet: a piece of metal that has the ability to attract iron or steel with magnetic force.

mass: the amount of matter in a substance.

mechanical energy: energy due to the motion of an object. For example: the energy of the moving parts of an automobile engine.

meter: a device that measures the amount of natural gas, water, or electricity that is being used.

methane: a colorless gas that burns easily. It forms from the decomposition of once living materials, or can be made from petroleum. Natural gas contains methane.

motion: moving, or movement from one place to another.

n

natural gas: a fossil fuel; a colorless gas containing methane that formed over millions of years from the remains of plants and animals. It must be pumped from the earth, and is used as a heat fuel because it burns easily and cleanly. Natural gas is a non-renewable energy source due to the conditions necessary to form it.

neutral: neither acid or basic, does not react.

nickel-cadium rechargeable battery: a dry cell battery with an alkaline (basic) electrolyte; a type of storage battery.

non-renewable energy sources: sources of energy that are in limited supply, and take millions of years to replace. For example: oil, coal, natural gas, uranium.

nuclear fuel: an energy source made from materials that must be mined from the ground and processed to obtain the radioactive elements. It is used as fuel in a nuclear reactor to produce electricity. Some nuclear fuels can be made by reprocessing other nuclear fuel after it is used.

o

oil: a fossil fuel; a thick, black liquid that is lighter than water, burns easily, and was formed over millions of years from the remains of plants and animals. It must be pumped from the earth and separated into products such as gasoline, kerosene, lubricants, plastics, etc. Oil causes air pollution when burned, and is a non-renewable energy source due to the conditions and time necessary to form it.

outlets: small openings in a wall where electrical plugs can be inserted to connect with wires that carry electricity.

p

penstock: a large pipe that carries water to a turbine in a hydroelectric plant.

pH: a measure of how acidic or basic a substance is. The pH scale goes from 0 to 14 with 7 being neutral, below 7 increasingly acidic, and above 7 increasingly basic.

pH paper: white paper saturated with litmus, used to indicate the pH of substances by changing color.

photosynthesis: the process by which green plants use sunlight to make food.

pipeline: a line of connected pipes used for carrying liquids or natural gas.

plants: any living things that are not animals. Plants are unable to move by themselves and lack a nervous system and sense organs. Green plants manufacture their own food.

q,r

rain: water falling to earth in drops from clouds.

recycle: to recover something so that it may be used again.

renewable energy sources: sources of energy that can be replenished in a short time, that are never really used up. For example: energy from the sun, wind, falling water, growing plants.

reservoir: a place where water is collected and stored for future use.

s

save: to keep from being used up or wasted.

snow: water vapor frozen into crystals that fall to earth in soft, white flakes.

soil: tiny particles of inorganic (rocks, minerals) and organic (decayed plants, animals) materials necessary for support and nourishment of plants.

sound: energy in the form of vibrations that travel through air, solids, and liquids, and produce "sounds" in the ear.

soundwaves: sound energy that travels through the air as a wave, at 1087 feet or 331 meters per second.

steam: the vapor that is given off when water is heated to the boiling point. Steam is a source of heat energy.

steam powered generating plant: a building that contains machines that make heat or electricity from steam. The steam is produced by burning coal, oil, natural gas, or garbage, or by using nuclear fuel, to boil water.

steam turbine: a turbine that produces electricity by using the force of steam to make it revolve.

storage battery: a battery that may be recharged after use.

substation: a building that has machines that help divide and regulate the flow of electricity from place to place.

sun: the star around which the earth and other planets revolve. The sun supplies the planets with light and heat.

sunlight: the light energy given off by the sun, which can be collected and used as a source of heat.

sun's energy: made up mostly of heat and light produced by the sun; known as solar energy. It can be collected and used to heat buildings and water, to produce electrical energy, and for lighting.

sustained: kept going.

t

temperature: a measure of heat or cold; a measure of the amount of energy in something.

thermometer: an instrument that measures heat energy.

thermostat: a device for sensing temperature; used to turn heating and cooling machines on and off at certain temperatures.

toxic substances: substances that are harmful to living things. These substances may also be useful products or byproducts of industry, energy production, etc.

transmission (car): the part of a motor vehicle that sends power from the engine to the axle(s) that turn the wheels.

transmission lines: heavy-duty wires that are used to carry electricity from one place to another, for example, from a generating plant to substations.

turbine: a device consisting of a wheel with blades that uses the force of water, wind, steam, or other hot gases to revolve it. A turbine is used to turn a generator to produce electricity.

u

utility company: a company that provides energy for people to use; sometimes owned by the public and sometimes by stockholders.

v

vapor: water in the air in the form of a gas.

vibrate: to move back and forth rapidly.

voicebox: the part of the throat that vibrates and produces the sounds of speech.

volt: the unit of measurement of the force needed to move electricity through a wire.

w

waste: to make poor use of, to use up without thought.

water: the most common liquid on earth, that falls from the sky as rain and forms rivers, oceans, etc. Pure water is colorless, tasteless, and odorless. Made up of hydrogen and oxygen.

water cycle: the process in which the sun evaporates water from the earth's surface, and the water is returned to the earth's surface in the form of precipitation from the atmosphere.

water power: energy (usually electricity) that is made from falling or running water.

water turbine: a turbine that uses the force of falling water to produce electricity.

water vapor: water in the form of a vapor.

watt: a unit of measurement of the amount of work done by an electric current per second (power).

weatherstripping: a material that is applied around doors and windows to reduce the flow of air.

wet cell battery: a battery with a liquid electrolyte.

wind: air in motion, caused by differences in the temperature and pressure of air masses.

windmill: a machine powered by the force of the wind on a wheel with vanes or sails, mounted on a tower; used to pump water, grind grain, generate electricity, etc.

wind-powered electric generator: an electric generator that is powered by a windmill or wind turbine.

wind turbine: a turbine that uses the force of the wind to produce electricity.

wood: a hard substance found beneath the bark of trees and shrubs. Wood is used as a fuel because it burns easily. It causes air pollution when burned. Wood is a renewable energy source because trees and shrubs can be replenished in a few years.

work: the use of the force of energy to move something a certain distance.

x,y,z

zinc-carbon battery: a standard dry-cell battery, which uses an acid for the electrolyte. It is not rechargeable.

Resources

Level I

I, 1. Everything Moves, by Seymour Simon
(New York: Walker and Company, 1976)

Popcorn Dragon, by Jane Thayer
(New York: William Morrow & Co., Inc., 1953)

Sometimes Things Change, by Patricia Eastman
(Chicago: Children's Press, 1983)

I, 2. Gravity All Around, by Tillie S. Pine and Joseph Levine
(New York: McGraw Hill Book Company, Inc., 1963)

Please, Wind?, by Carol Greene
(Chicago: Children's Press, 1982)

I, 3. The Cloud Book, by Tomie de Paola
(New York: Holiday House, 1975)

The Day We Saw the Sun Come Up, by Alice E. Goudey
(New York: Charles Scribner's Sons, 1961)

Rain and Hail, by Franklyn M. Branley
(New York: Thomas Y. Crowell Company, 1963)

Science Experiences: Solids, Liquids, and Gases, by Jeanne Bendick
(New York: Franklin Watts, Inc., 1984)

I, 4. Rusty Rings a Bell, by Franklyn M. Branley
(New York: Thomas Y. Crowell Company)

I, 5. Energy from the Sun, by Melvin Berger
(New York: Thomas Y. Crowell Company, 1976)

Roots Are Food Finders, by Franklyn Branley
(New York: Thomas Y. Crowell Company, 1975)

I, 6. Energy, Food, and You, (elementary booklet)
(Washington State Office of Environmental Education, c/o Shoreline School District Administration Building, NE 158th and 20th Ave., NE, Seattle, WA 98155)

What Happens to a Hamburger, by Paul Showers
(New York: Thomas Y. Crowell, Company, 1970)

I, 7. Heat, by Vicki Cobb
(New York: Franklin Watts, Inc., 1973)

Hot and Cold, by Irving Adler
(New York: Harper & Row, John Day Junior Books, 1975)

I, 8. How We Move Things (filmstrip)
(Popular Science Publishing Company, 1962)

I, 9. Arthur's New Power, by Russell Hoban
(New York: Thomas Y. Crowell Company, 1978)

Blackout, by Anne and Harlow Rockwell
(New York: Macmillan Publishing Company, Inc., 1979)

Play It Safe -- Away from Electricity
(South Deerfield, MA: Channing L. Bete Co., Inc., 1977)

I, 10. Energy from the Sun, by Melvin Berger
(New York: Thomas Y. Crowell Company, 1976)

I, 11. More Power to You: An Energy Conservation Puppet Show
(The Peppermint Playhouse Puppeteers, 620 Red Oak Drive, River Vale, NJ 07675. Telephone: 201-666-2275)

I, 12. The Berenstain Bears' Science Fair, by Stan and Jan Berenstain
(New York: Random House, Inc., 1977)

Energy Mobile (kit of cut-outs and teachers' guide)
(NYS Energy Office, Office of Communications, 2 Rockefeller Plaza, Albany, NY 12223)

Level II

II, 1. Wind, (10 minute color film)
(National Film Board of Canada, 1973)

Energy All Around Us, by Tillie S. Pine and Joseph Levine
(New York: McGraw-Hill Book Co., 1975)

Energy at Work, by John Satchwell
(New York: Lothrop, Lee and Shepard Books, 1981)

Energy Does Work, (13 min. color film)
(Barr Films, 1981)

Feast or Famine? The Energy Future, by Franklyn Branley
(New York: Thomas Y. Crowell Company, 1980)

Powers of Nature (filmstrip)
(Washington, D.C.: National Geographic Society, 1973)

Where Are You Going with That Energy?, by Roy Doty and Leonard Marr
(New York: Doubleday & Co., Inc., 1977)

II, 2. Science Experiments with Sound, by Harry Sootin
(New York: W. W. Norton & Co., 1964)

Sound and Recording, by Keith Wicks
(New York: Franklin Watts, Inc., Warwick Press, 1982)

Thunder, Singing Sands, and Other Wonders: Sound in the Atmosphere, by Kenneth Heuer
(New York: Dodd, Mead, Co., 1981)

Wonders of Sound, by Rocco Ferauolo
(New York: Dodd, Mead & Co., 1962)

II, 3. Dining on a Sunbeam: Food Chains and Food Webs, by Phyllis S. Busch
(New York: Four Winds Press, 1973)

How to Grow a Jelly Glass Farm, by Kathy Mandry and Joe Toto
(New York: Pantheon Books, 1974)

Making a Native Plant Terrarium, by D. J. Herda
(New York: Julian Messner, 1977)

Putting the Sun to Work, by Jeanne Bendick
(Champaign, IL: Garrard Publishing Company, 1979)

The Sun: Earth's Star (20 min. color film to rent)
(National Geographic Society, Educational Services, 1980)

Terrariums, by Alice Parker
(New York: Franklin Watts, Inc., 1977)

The True Book of Weather Experiments, by Illa Podendorf
(Chicago: Children's Press, 1961)

Who Stole the Water (10 min. color film/video to rent)
(Macmillan Films, 1975)

II, 4. Factory Made: How Things are Manufactured, by Leonard Gottlieb
(Boston, MA: Houghton Mifflin, Co., 1978)

From Apple Seed to Applesauce, by Hannah Lyons Johnson
(New York: Lothrop, Lee, & Shepard Books, 1978)

How's It Made?: A Photo Tour of Seven Small Factories, by Stephen Lewis
(New York: William Morrow & Co., 1977)

How Things are Made
(Washington, D.C.: National Geographic Society, 1981)

Your Career in Energy-Related Occupations, by George Davis
(New York: Arco Publishing Co., 1980)

Toast (12 minute film)
(NYS Energy Office, AV Library, 2 Rockefeller Plaza, Albany, NY 12223, 1977)

II, 5. Experiments with Heat, by Harry Soutin
(New York: W. W. Norton & Co., 1964)

Heat, by Vicki Cobb
(New York: Franklin Watts, Inc., 1973)

Heat and Its Uses, by Irving and Ruth Adler
(New York: Harper & Row, John Day Junior Books, 1973)

Hot and Cold, by Irving Adler
(New York: Harper & Row, John Day Junior Books, 1975)

Hot as an Ice Cube, by Philip Balestrino
(New York: Thomas Y. Crowell Company, 1971)

II, 6. Energy Conservation: Experiments You Can Do . . . from Edison
(Southfield, MI: Thomas Alva Edison Foundation, 1981)

II, 7. Flash, Crash, Rumble, and Roll, by Franklyn M. Branley
(New York: Thomas Y. Crowell Company, 1964)

The Lightning and Thunder Case (animated film or video to rent)
(Learning Corporation of America, 1981)

II, 8. Making Electricity Work, by John M. Kennedy
(New York: Thomas Y. Crowell Company, 1959)

Wires and Watts, by Irwin Math
(New York: Charles Scribner's Sons, 1981)

II, 9. Experiments with Electric Currents, by Harry Sootin
(New York: W. W. Norton & Co., 1969)

The Magic of Electricity, by Sam Rosenfeld
(New York: Lothrop, Lee & Shepard Books, 1963)

II, 10. Saving Electricity, by Sam and Beryl Epstein
(Champaign, IL: Garrard Publishing Co., 1977)

II, 11. Cup and Saucer Chemistry, by Nathan Shalit
(Morristown, NJ: Shalit Literary Service, 1983)

First Chemistry Book for Boys and Girls, by Alfred Powell Morgan
(New York: Charles Scribner's Sons, 1977)

Kitchen Chemistry: Science Experiments to Do at Home, by Robert Gardner
(New York: Julian Messner, 1982)

Messing Around with Baking Chemistry: A Children's Museum Activity Book, by Bernie Zubrowski
(Boston, MA: Little, Brown & Co., 1981)

II, 13. Conservation of Energy, by Jane Werner Watson
(New York: Franklin Watts, Inc., 1978)

Energy Monsters: How to Starve Them, (film 13 min, color to rent)
(BFA Educational Media, 1978)

Future Sources, by John Satchwell
(New York: Franklin Watts Inc., 1981)

Oil, by Barbara Lowery
(New York: Franklin Watts Inc., 1977)

The Alternate Energy Suite (tape cassette and supplementary materials)
(Conservation Consultants, 417 Thorn St., Sewickley, PA 15143)

Level III

III, 1. American Windmills, by Sharon Cosner
(New York: David McKay Co., 1977)

Catch the Wind, by Landt Dennis
(New York: Four Winds Press, 1976)

Motors and Engines and How They Work, by Harvey Weiss
(New York: Thomas Y. Crowell Company, 1969)

III, 2. The Boys' Book of Engines, Motors and Turbines, by Alfred Morgan
(New York: Charles Scribner's Sons, 1946)

Motors and Engines and How They Work, by Harvey Weiss
(New York: Thomas Y. Crowell Company, 1969)

III, 3. Machines, by Jerome S. Meyer
(Cleveland: World Publishing Co., 1968)

The Simple Facts of Simple Machines, by Elizabeth James and Carol Barkin
(New York: Lothrop, Lee & Shepard Co., 1975)

Simple Machines and How We Use Them, by Tillie Pine and Joseph Levine
(New York: McGraw Hill Co., 1965)

III, 4. Solar Energy, by Franklyn M. Branley
(New York: Thomas Y. Crowell and Company, 1957)

Sun Power, by Steve J. Gadlert and Wendy W. Adamson
(Minneapolis: Lerner Publishing Co., 1978)

III, 5. Experiments with Heat, by Harry Soutin
(New York: W. W. Norton & Co., 1964)

Heat and Its Uses, by Irving and Ruth Adler
(New York: The John Day Co., 1973)

Ice Cubes, Elementary Science Study
(St. Louis: McGraw-Hill Book Company, Inc., 1975)

III, 6. Heat and Its Uses, by Irving and Ruth Adler
(New York: The John Day Co., 1973)

Solar Energy, by Franklyn M. Branley
(New York: Thomas Y. Crowell and Company, 1957)

Sunpower Experiments: Solar Energy Explained, by Maggie Spooner
(New York: Sterling Publishing Co., 1980)

III, 7. The Boys' Book of Engines, Motors and Turbines, by Alfred Morgan
(New York: Charles Scribner's Sons, 1946)

Motors and Engines and How They Work, by Harvey Weiss
(New York: Thomas Y. Crowell Company, 1969)

Machines, by Jerome S. Meyer
(Cleveland: World Publishing Co., 1968)

III, 8. The Boys' Book of Engines, Motors and Turbines, by Alfred Morgan
(New York: Charles Scribner's Sons, 1946)

Batteries and Bulbs, Elementary Science Study
(St. Louis: McGraw-Hill Book Company, Inc., 1968)

Magnetism, Electricity, Sound, by Rocco V. Ferauolo
(New Jersey: Prentice Hall, Inc., 1968)

Picture Book of Electricity, by Jerome Meyer
(New York: Lothrop, Lee & Shepard, 1953)

III, 9. The Boys' Book of Engines, Motors and Turbines, by Alfred Morgan
(New York: Charles Scribner's Sons, 1946)

Energy & Environment, by Norman F. Smith
(Austin, TX: Steck-Vaughn, Co., 1974)

III, 10. Electricity, by Leslie Waller
(New York: Holt, Rinehart & Winston)

Junior Science Book of Electricity, by Rocco V. Ferauolo
(Champaign, IL: Garrard Press, 1960)

Picture Book of Electricity, by Jerome Meyer
(New York: Lothrop, Lee & Shepard, 1953)

Science at Work, by Seymour Simon
(New York: Franklin Watts, Inc., 1971)

III, 11. Electricity
(Irving, TX: Boy Scouts of America, 1984)

Energy, The New Look, by Margaret O. Hyde
(New York: McGraw-Hill Book Company, Inc., 1981)

It Works Like This, by Thomas G. Aylesworth
(Garden City, NY: Doubleday & Co., 1968)

III, 12. About Garbage and Stuff, by Ann Zane Shanks
(New York: The Viking Press, 1973)

Recycling, by James and Lynn Hahn
(New York: Franklin Watts, Inc., 1973)

Recycling Resources, by Laurence Pringle
(New York: Macmillan Publishers, 1974)

III, 13. Chemistry, by Jane Chisholm and Mary Johnson
(London: Usborne Publishing Co., 1983)

What Makes a Lemon Sour?, by Gail K. Haines
(New York: William Morrow & Co., 1977)

Matrix

The matrix on the following pages is taken from the draft edition of the New York State Education Department's elementary science syllabus.

The state syllabus divides learning objectives into three categories:

understandings,
skills, and
attitudes.

In Energy and Safety, the major state objectives addressed are listed on the first page of each activity, in a box, under the titles "Understandings," "Skills," and "Attitudes," as in the state syllabus. However, any given activity actually addresses many objectives. This matrix is designed to show all the objectives that are introduced, taught, or reinforced by each activity. Its purpose is to help teachers use the Energy and Safety activities in conjunction with the state syllabus.

Key:

⧄ means the activity introduces this understanding, skill or attitude.

■ means the activity teaches this understanding, skill or attitude.

☒ means the activity reinforces this understanding, skill, or attitude.

SYLLABUS - PROGRAM CORRELATION CHART

Level I, Grades K-2

		Activities											
		1	2	3	4	5	6	7	8	9	10	11	12
INQUIRY SKILLS	CLASSIFYING	/			■			☒	☒	☒	☒		
	CREATING MODELS								/	■		☒	☒
	FORMULATING HYPOTHESES												
	GENERALIZING												/
	IDENTIFYING VARIABLES												
	INFERRING						/						
	INTERPRETING DATA											/	
	MAKING DECISIONS												
	MANIPULATING MATERIALS		/	/		/			/	/			
	MEASURING			/			/	/				/	
	OBSERVING	■	☒	☒	☒	☒	☒	☒	☒	☒		☒	
	PREDICTING		/						/				
	RECORDING DATA			/				/					
	REPLICATING				/								
	USING NUMBERS											/	
LANGUAGE ARTS SKILLS/ PROCESSES	CLASSIFYING	/			■			☒	☒	☒	☒		
	DEVELOPING VOCABULARY	/	/	/	/	/		/		/	■	☒	☒
	MANIPULATING IDEAS												
	QUESTIONING	/					/	/					
	RECORDING DATA			/				/					
	USING CUES				/						/		
	ACQUIRING INFORMATION										/		
	COMMUNICATING INFORMATION												/
SCIENCE ATTITUDES	A. APPRECIATING, ENJOYING, NATURE					/							
	1. UNDERSTANDING, NATURAL WORLD			/		/							/
	1.1 APPRECIATING NATURAL WORLD	/	/										
	1.11 COMPLEXITY, DIVERSITY, INTRICACY, ETC.	/	/										
	1.12 RESOURCE, HUMAN NEEDS						/	/			■	☒	
	1.2 RESPECTING LIFE						/						
	1.21 INDIVIDUAL LIFE, PRECIOUS												
	1.22 SOURCE FOR CONTINUATION												
	1.23 AGING PROCESS												
	1.3 WANTING TO KNOW, UNDERSTAND	/			/								
	1.31 CONCEPTS, TERMS, TECHNIQUES, ETC.												
	1.32 ACCURATE INFORMATION												
	1.33 EXPLANATIONS, INTERPRETATIONS, PREDICTIONS		/	/	/								
	2. INVESTIGATIVE METHODS, NATURAL WORLD					/							
	2.1 SKEPTICISM, INVESTIGATION, REASONING												
	2.11 UNCERTAINTY OF INFORMATION, VERIFICATION												
	2.12 AMBIGUITY, CONTRADICTION, TENTATIVENESS												
	2.13 ORIGINAL INSIGHT, INFERENCES, ETC.												
	2.14 CAREFUL, SYSTEMATIC INVESTIGATION												
	2.15 LOGICAL REASONING, VALIDITY OF IDEAS												
	2.2 RESPECTING OTHERS, ENVIRONMENT												/
	2.21 SAFETY	/	/	/	/		/	/	/	/			■
	2.22 USE OF RESOURCES											■	☒
	2.23 CONTRIBUTING FAIR SHARE OF EFFORT												
	2.24 CONTRIBUTIONS, OTHERS												
	2.25 TRUTHFUL REPORTING												
	2.26 BELIEFS AND VALUES OF OTHERS												
	B. VALUING USE OF KNOWLEDGE FOR SOCIETY							/					
	1. THE PRACTICAL, TECHNICAL							/	■	☒	☒	☒	
	1.1 SCIENTIFIC TECHNIQUES, MATERIALS		/	/									
	1.2 RESOURCEFULNESS, INNOVATIVENESS								/				
	1.3 TECHNIQUE EFFICIENCY, SIMPLICITY, ETC.								/				
	2. SERVICE THROUGH TECHNOLOGY												
	2.1 NEEDS, PROBLEMS OF OTHERS												
	2.2 BENEFITS OF TECHNOLOGICAL CHANGE									/			
	2.3 POTENTIAL ADVERSE CONSEQUENCES												

Level I continued

		Activities											
		1	2	3	4	5	6	7	8	9	10	11	12
LIFE SCIENCE (LEVEL 1)	1. NATURAL WORLD												
	1A. PLANTS, ANIMALS, NEEDS					/	■	☒	☒	☒	☒	☒	☒
	1. PLANTS, PROPERTIES, NEEDS					/							
	1.1 PLANT PARTS, FUNCTIONS					/							
	1.11 ROOTS					/							
	1.12 LEAVES					/							
	1.13 STEMS, STALKS, TRUNKS, ETC.					/							
	1.2 PLANT PARTS, IMMEDIATE NEEDS					/							
	1.3 PLANT PARTS, SEASONAL CHANGES					/							
	1.4 PLANT GROWTH AND DEVELOPMENT, LIFE SPAN					/							
	1.41 SEED, SEEDLING, ADULT												
	1.42 BULB, SEEDLING, ADULT												
	1.43 LENGTH OF LIFE SPAN												
	1.5 PLANT PART VARIATIONS												
	2. ANIMALS, PROPERTIES, NEEDS							/					
	2.1 ANIMAL PARTS, FUNCTIONS												
	2.11 WINGS, LEGS, FINS												
	2.12 MOUTH, TEETH, JAWS, TONGUE												
	2.13 NOSTRIL												
	2.14 EYES, NOSE, EAR, TONGUE, SKIN												
	2.15 CLAWS, SHELLS, ETC.												
	2.16 BODY COVERING												
	2.17 PARTS, SOUND												
	2.2 ANIMAL PARTS, IMMEDIATE NEEDS												
	2.3 ANIMAL PARTS, SEASONAL NEEDS												
	2.4 ANIMAL GROWTH AND DEVELOPMENT, LIFE SPAN												
	2.41 INFANCY TO ADULT STAGES												
	2.42 LENGTH OF LIFE SPAN												
	2.5 ANIMALS, CONTROL CONDITIONS, NEEDS							■		☒	☒	☒	☒
	2.6 ANIMALS, MOTION, NEEDS								/			/	
	2.7 ANIMAL PART VARIATIONS												
	1B. PLANTS, ANIMALS, DEPENDENCY						/				■	☒	☒
	1. ANIMALS -- PLANTS						/						
	2. PLANTS -- ANIMALS												
	3. ANIMALS -- ANIMALS						/						
PHYSICAL SCIENCE (LEVEL 1)	1C. OBJECTS, EVENTS, PROPERTIES	/	/	■	☒			☒	☒	☒			
	1. OBJECT PROPERTIES, MATERIAL, CONDITION	/	/	■									
	1.1 OBJECT PROPERTIES, MATERIAL												
	1.11 DIFFERENT MATERIALS/PROPERTIES												
	1.12 CHANGING SIZE, SHAPE												
	1.13 SOLID, LIQUID, GAS			/									
	1.14 MIXTURES												
	1.2 OBJECT PROPERTIES, LOCATION IN SPACE												
	1.3 OBJECT PROPERTIES, AMOUNT OF SPACE												
	1.4 TWO OBJECTS, SAME SPACE												
	1.5 OBJECT PROPERTIES, SURROUNDING CONDITIONS	/	/	■	☒								
	2. EVENT PROPERTIES, OBJECTS, SPACE, TIME				/								
	2.1 EVENT, TIME, PLACE IN SPACE				/								
	2.2 EVENT, DURATION OF TIME				/								
	2.3 EVENTS, SEQUENCE, ORDER, SPACE				/								
	2.4 TWO EVENTS, TIME												
	2.5 REPEATING EVENTS, INTERVALS OF TIME												
	2.6 EVENTS, MOTION, SPACE								/				
	1D. INTERACTION, OBJECTS, EVENTS	/	■	☒	☒				☒				
	1. OBJECTS -- HEAT	/	/	■				☒					
	1.1 HEATING, COOLING, WARMER, COLDER		/	/				■					
	1.2 HEATING MATERIALS, LIQUIDS, GASES			■									
	1.3 COOLING MATERIAL, LIQUIDS, SOLIDS			/									
	1.4 HEATING, COOLING, VOLUME CHANGE												
	2. OBJECT, MOTION, PUSH-PULL	/	/						■				
	2.1 DIRECTION OF PUSH-PULL, CHANGE IN MOTION		/										
	2.2 SIZE OF PUSH-PULL, OBJECT MASSIVENESS, MOTION												
	2.3 SURFACE CONDITION, SIZE OF PUSH-PULL, MOTION												
	3. OBJECTS, SUPPORTED BY OBJECTS												
	3.1 UNIFORM BALANCE BEAM												
	3.11 TWO OBJECTS, EQUAL WEIGHT, BALANCE POINT												
	3.12 TWO OBJECTS, DIFF. WEIGHT, BALANCE POINT												
	3.2 OBJECTS, FLOATING, SINKING												

SYLLABUS - PROGRAM CORRELATION CHART
LEVEL II, GRADES 3-4

		Activities												
		1	2	3	4	5	6	7	8	9	10	11	12	13
INQUIRY SKILLS	CLASSIFYING	/			/					■				
	CREATING MODELS				/		/				/			■
	FORMULATING HYPOTHESES	/	/					/				/		
	GENERALIZING									/			/	/
	IDENTIFYING VARIABLES													
	INFERRING		/			/		/	/	/				
	INTERPRETING DATA		/	/	/		/					■	X	
	MAKING DECISIONS										/			
	MANIPULATING MATERIALS			/		/	/	■	X	X		X		
	MEASURING			/		■						X		
	OBSERVING	■	X	X		X	X	X	X	X		X	X	
	PREDICTING						■							
	RECORDING DATA	/	/	■		X	X	X	X	X		X	X	
	REPLICATING								/					
	USING NUMBERS					/							■	X
LANGUAGE ARTS SKILLS/ PROCESSES	CLASSIFYING	/			/									
	DEVELOPING VOCABULARY	/	/		/		/	/			/			
	MANIPULATING IDEAS													
	QUESTIONING	/												
	RECORDING DATA	/	/	■		X	X	X	X	X		X	X	
	USING CUES										/			
	ACQUIRING INFORMATION		/		/			/			■			X
	COMMUNICATING INFORMATION	/	/		/	/		/						/
SCIENCE ATTITUDES	A. APPRECIATING, ENJOYING, NATURE			/										
	1. UNDERSTANDING, NATURAL WORLD	/												
	1.1 APPRECIATING NATURAL WORLD													
	1.11 COMPLEXITY, DIVERSITY, INTRICACY, ETC.	/												
	1.12 RESOURCE, HUMAN NEEDS				■							X		
	1.2 RESPECTING LIFE													
	1.21 INDIVIDUAL LIFE, PRECIOUS													
	1.22 SOURCE FOR CONTINUATION													
	1.23 AGING PROCESS													
	1.3 WANTING TO KNOW, UNDERSTAND													
	1.31 CONCEPTS, TERMS, TECHNIQUES, ETC.													
	1.32 ACCURATE INFORMATION									/				
	1.33 EXPLANATIONS, INTERPRETATIONS, PREDICTIONS								■			/		
	2. INVESTIGATIVE METHODS, NATURAL WORLD	/												
	2.1 SKEPTICISM, INVESTIGATION, REASONING					/								
	2.11 UNCERTAINTY OF INFORMATION, VERIFICATION													
	2.12 AMBIGUITY, CONTRADICTION, TENTATIVENESS		/						/			/		
	2.13 ORIGINAL INSIGHT, INFERENCES, ETC.													
	2.14 CAREFUL, SYSTEMATIC INVESTIGATION		/	/		/		/		■		X		
	2.15 LOGICAL REASONING, VALIDITY OF IDEAS												/	
	2.2 RESPECTING OTHERS, ENVIRONMENT													
	2.21 SAFETY	/	/					/	/	/	/	/	/	
	2.22 USE OF RESOURCES				/	/	/						/	■
	2.23 CONTRIBUTING FAIR SHARE OF EFFORT													
	2.24 CONTRIBUTIONS, OTHERS													
	2.25 TRUTHFUL REPORTING							/						
	2.26 BELIEFS AND VALUES OF OTHERS													
	B. VALUING USE OF KNOWLEDGE FOR SOCIETY										/			
	1. THE PRACTICAL, TECHNICAL				/						/		/	
	1.1 SCIENTIFIC TECHNIQUES, MATERIALS			/			/		/	/		/		
	1.2 RESOURCEFULNESS, INNOVATIVENESS						/							
	1.3 TECHNIQUE EFFICIENCY, SIMPLICITY, ETC.													
	2. SERVICE THROUGH TECHNOLOGY													
	2.1 NEEDS, PROBLEMS OF OTHERS													■
	2.2 BENEFITS OF TECHNOLOGICAL CHANGE													
	2.3 POTENTIAL ADVERSE CONSEQUENCES													

		Activities												
	Level II continued	1	2	3	4	5	6	7	8	9	10	11	12	13
LIFE SCIENCE (LEVEL II)	IIA. PLANTS, ANIMALS, NEW GENERATIONS													
	1. FLOWERS, SUFFICIENT SEEDS, SURVIVAL, NEW GENERATION													
	1.1 GENERATION, STAGES, LIFE CYCLE													
	1.2 FLOWERS, SEEDS													
	1.21 POLLEN TRANSFER, SEEDS													
	1.22 POLLEN TRANSFER AIDS													
	1.23 SEEDS, FRUIT													
	1.3 SEED CHARACTERISTICS, SURVIVAL													
	1.31 DISPERSAL													
	1.32 SEVERE CONDITIONS, TEMPERATURE, DROUGHT													
	1.33 GERMINATION, SUITABLE CONDITIONS													
	1.34 STORED FOOD													
	1.4 OTHER STRUCTURES, OFFSPRING													
	1.5 PLANT POTENTIAL FOR OFFSPRING													
	1.51 NUMBERS OF FLOWERS, SEEDS													
	1.52 ACTUAL CONDITIONS, SURVIVAL POPULATION													
	2. FEMALE ANIMALS, SUFFICIENT YOUNG, SURVIVAL, NEW GEN.													
	2.1 GENERATION, STAGES, LIFE CYCLE													
	2.2 CARE FROM ADULTS, LIVE, THRIVE													
	2.3 YOUNG ANIMALS, LIVE, THRIVE, INDEPENDENT													
	2.4 ANIMAL POTENTIAL FOR OFFSPRING													
	2.41 ACTUAL CONDITIONS, SURVIVAL, POPULATION													
	IIB. DIFFERENT KINDS, PLANTS, ANIMALS, DEPENDENCY, COMMUNITY			/	■						☒	☒		☒
	1. PLANTS, ANIMAL FOOD SUPPLY, SUN ENERGY			■	☒									
	1.1 FOOD CHAIN				/									
	1.2 FOOD WEB											/		
	2. POPULATION SIZE, DEPENDENCIES, FOOD													
	2.1 ANIMAL POPULATION, FOOD SUPPLY													
	2.2 ANIMAL POPULATION CHANGE, FOOD SUPPLY CHANGES													
PHYSICAL SCIENCE (LEVEL II)	IIC. ENERGY, MATERIAL, FORMS, PROPERTIES	/					/	/		/		■		
	1. OBJECT PROPERTIES, FORMS, AMTS., PROP. OF MATERIALS	/					/			■		☒		
	1.1 MATERIAL PROPERTIES, FORM													
	1.11 SHAPE													
	1.12 SOLID, LIQUID, GAS													
	1.13 SIZE OF CONTAINED SOLID PARTICLES													
	1.2 OBJECT PROPERTIES, AMOUNT OF MATERIAL													
	2. ENERGY FORM, AMOUNT, ABILITY TO MOVE	■	☒			☒		☒			☒			☒
	2.1 ENERGY FORMS	■	☒	☒	☒	☒		☒				☒	☒	
	2.2 ENERGY MOVEMENT, BETWEEN, THROUGH		■			■			☒	☒	☒			
	2.3 ENERGY, AMOUNTS AVAILABLE												■	☒
	IID. INTERACTIONS, MATERIALS, ENERGY, SYSTEMS	/		/	■	☒	☒	☒	☒	☒		☒		
	1. ENERGY CHANGES, INTERACTIONS	/						/	■	☒		■		
	2. ENERGY TRANSFER, SYSTEM					/	■	☒	☒	☒	☒	☒		
	3. ENERGY, INTERACTION, OBJECT PROPERTIES			■	☒		■	☒				☒		

SYLLABUS - PROGRAM CORRELATION CHART
Level III, Grades 5 - 6

		Activities												
		1	2	3	4	5	6	7	8	9	10	11	12	13
INQUIRTY SKILLS	CLASSIFYING							■		☒				☒
	CREATING MODELS	/	■				☒							
	FORMULATING HYPOTHESES			/		/			■					
	GENERALIZING	/	/						/			/		
	IDENTIFYING VARIABLES									/				
	INFERRING								■					
	INTERPRETING DATA	/	/		■	☒		☒				☒		☒
	MAKING DECISIONS													
	MANIPULATING MATERIALS	/	■	☒	☒				☒		☒		☒	☒
	MEASURING			/	/	■	☒						☒	
	OBSERVING	/	/	■		☒	☒	☒	☒		☒			☒
	PREDICTING													
	RECORDING DATA	/	/	/	■	☒	☒	☒			☒	☒	☒	☒
	REPLICATING							/		■	☒			
	USING NUMBERS			/	/	■						■		
LANGUAGE ARTS SKILLS/ PROCESSES	CLASSIFYING							■		☒				
	DEVELOPING VOCABULARY				/		/	/		/	/	/		/
	MANIPULATING IDEAS													
	QUESTIONING						/							
	RECORDING DATA	/	/	/	■	☒	☒	☒			☒	☒		☒
	USING CUES							/		/		/		
	ACQUIRING INFORMATION	/	/		/		/		/	■	☒		☒	☒
	COMMUNICATING INFORMATION				/		■		☒		☒			☒
SCIENCE ATTITUDES	A. APPRECIATING, ENJOYING, NATURE													
	1. UNDERSTANDING, NATURAL WORLD	/												
	1.1 APPRECIATING NATURAL WORLD													
	1.11 COMPLEXITY, DIVERSITY, INTRICACY, ETC.													
	1.12 RESOURCE, HUMAN NEEDS				/								/	
	1.2 RESPECTING LIFE													
	1.21 INDIVIDUAL LIFE, PRECIOUS													
	1.22 SOURCE FOR CONTINUATION													
	1.23 AGING PROCESS													
	1.3 WANTING TO KNOW, UNDERSTAND													
	1.31 CONCEPTS, TERMS, TECHNIQUES, ETC.									/		/		/
	1.32 ACCURATE INFORMATION						/							
	1.33 EXPLANATIONS, INTERPRETATIONS, PREDICTIONS	/	/									/		
	2. INVESTIGATIVE METHODS, NATURAL WORLD													
	2.1 SKEPTICISM, INVESTIGATION, REASONING			/										
	2.11 UNCERTAINTY OF INFORMATION, VERIFICATION													
	2.12 AMBIGUITY, CONTRADICTION, TENTATIVENESS							/	/					
	2.13 ORIGINAL INSIGHT, INFERENCES, ETC.													
	2.14 CAREFUL, SYSTEMATIC INVESTIGATION		/			■	☒		☒					/
	2.15 LOGICAL REASONING, VALIDITY OF IDEAS					/								
	2.2 RESPECTING OTHERS, ENVIRONMENT												/	/
	2.21 SAFETY				/				/					/
	2.22 USE OF RESOURCES	/	/			/	/						/	/
	2.23 CONTRIBUTING FAIR SHARE OF EFFORT										/			
	2.24 CONTRIBUTIONS, OTHERS													
	2.25 TRUTHFUL REPORTING													
	2.26 BELIEFS AND VALUES OF OTHERS													
	B. VALUING USE OF KNOWLEDGE FOR SOCIETY						/							
	1. THE PRACTICAL, TECHNICAL			/				/		/		■		
	1.1 SCIENTIFIC TECHNIQUES, MATERIALS	/	■										☒	
	1.2 RESOURCEFULNESS, INNOVATIVENESS										/			
	1.3 TECHNIQUE EFFICIENCY, SIMPLICITY, ETC.													
	2. SERVICE THROUGH TECHNOLOGY													
	2.1 NEEDS, PROBLEMS OF OTHERS													
	2.2 BENEFITS OF TECHNOLOGICAL CHANGE												■	
	2.3 POTENTIAL ADVERSE CONSEQUENCES													■

Activities

	Level III, continued	1	2	3	4	5	6	7	8	9	10	11	12	13
LIFE SCIENCE (LEVEL III)	IIIA. LIVING THINGS, AFFECT ON ENVIRONMENT				╱		╱							╱
	1. LIFE OF PLANT, ENVIRONMENTAL CONDITIONS													
	1.1 PLANT HEALTH, GROWTH, DEVELOPMENT													
	1.2 PLANT CHANGE, ENVIRONMENTAL CHANGE, SURVIVAL													
	1.21 PLANT PART MOVEMENT													
	1.22 PLANT PART FORMATION													
	1.3 GREEN PLANT, LIGHT FORMATION				╱									
	1.31 LEAVES, LIGHT ABSORPTION, ENERGY TRANSFORM.				■									
	1.32 ABSORBED AND STORED ENERGY, UTILIZATION													
	1.33 STORED ENERGY, FOOD SUPPLY, SEED, GROWING PLANT													
	1.4 PLANT, AFFECT, ENVIRONMENT													
	2. LIFE OF ANIMAL, ENVIRONMENTAL CONDITIONS						╱							╱
	2.1 ANIMAL HEALTH, GROWTH, DEVELOPMENT						╱							╱
	2.2 ANIMAL BEHAVIOR CHANGE, ENVIRONMENTAL CHANGE													
	2.21 ANIMALS MOVEMENT, OPTIMAL CONDITIONS													
	2.22 ANIMAL CHARACTERISTICS, ENVIRON. INFLUENCE													
	2.23 ROUTINE BEHAVIOR, ENVIRONMENTAL INFLUENCE													
	2.3 SOURCES OF ENERGY						╱							
	2.31 STORED ENERGY, FOOD													
	2.32 HEAT ENERGY, SUN													
	2.33 HEAT ENERGY, FUEL UTILIZATION						■							
	2.4 ANIMAL BEHAVIOR, AFFECT, ENVIRONMENT													
	IIIB. ENVIRON. CONDITIONS, INFLUENCE, POPULATIONS, COMMUNITY													╱
	1. DIFFERENT KINDS, POPULATIONS, VARIOUS ENVIRONMENTS													
	2. ENVIRONMENTAL CONDITION CHANGE, POPULATION SIZE CHANGE													╱
	2.1 CONDITIONS, DIRECT EFFECT, POPULATION SIZES													
	2.2 CONDITIONS, DIRECT EFFECT, FOOD CHAIN													
PHYSICAL SCIENCE (LEVEL III)	IIIC. ENERGY, WITHIN MATERIAL, POSITION, MOTION, OBJECTS	╱	╱	╱		╱			╱					
	1. ENERGY TRANSFER WITHIN MATERIALS								╱					
	1.1 ELECTRICAL ENERGY, CIRCUITS								■	☒	☒			
	1.11 POSITIVE, NEGATIVE CHARGES													
	1.12 BATTERIES, ENERGY STORAGE										╱			
	1.13 COMPLETE CIRCUIT, ENERGY FLOW										■			
	1.14 RATE OF FLOW, VOLTAGE, TRANSFER AMOUNT										╱			
	1.15 MAGNETIC FIELD, FLOWING ELECTRICITY													
	1.16 MOVING MAGNET, FLOW OF ELECTRICITY								■	☒				
	1.2 INTERACTIONS, MATERIALS, ENERGY										╱			╱
	1.21 NEW MATERIALS													╱
	1.22 STARTING ENERGY													
	1.23 ENERGY EMITTED										╱			
	1.24 ENERGY ABSORBED													
	1.3 HEAT FLOW					■								
	1.31 AMOUNT OF MATERIAL					■								
	1.32 TYPES OF MATERIAL													
	1.33 TEMPERATURE DIFFERENCE													
	1.34 MOVEMENT OF MATERIAL													
	2. ENERGY TRANSFER, MOTION, OBJECTS	╱	■	☒										
	2.1 WORK, ENERGY TRANSFER													
	2.11 LIFTING OBJECTS, HEAVY		■											
	2.12 MOVING OBJECTS, SPEED	■												
	2.2 AMOUNT OF WORK, FORCE, DISTANCE			■										
	2.21 INCLINED PLANE, LEVER, CHANGING FORCE			╱										
	2.22 SIMPLE MACHINES, CHANGING DISTANCE			╱										
	2.23 MACHINE, OBJECT-FORCE-DISTANCE RELATIONSHIP			╱										
	2.3 MAN-MADE TOOLS, MACHINES			╱										
	2.4 FORCES, LIQUIDS, GASES													
	2.41 CLOSED CONTAINER, FORCE													
	2.42 FORCE, AREA, PRESSURE													
	2.43 PRESSURE, DEPTH, FLUID													
	IIID. MATERIAL AND ENERGY TRANSFER, INTERACTIONS, SYSTEMS						╱	■		☒		☒	☒	☒
	1. CHANGES IN FORM							■		☒				
	2. CHANGES IN LOCATION							■		☒		☒		☒
	3. LOSSES FROM A SYSTEM							■						
	4. MAINTAINING INTERACTIONS						╱	■		☒		☒		

Level III, continued

		Activities 1	2	3	4	5	6	7	8	9	10	11	12	13
ECOSYSTEMS	IIIE. ECOSYSTEM				✓							✓	✓	✓
	1. MATERIAL RECYCLING, PHYS. ENVIRON., LIVING COMMUNITY													
	1.1 MATERIAL, ABSORPTION, GREEN PLANTS													
	1.2 MATERIAL ABSORPTION, ANIMALS													
	1.3 MATERIAL UTILIZATION, WASTE													
	1.4 MATERIAL DECAY													
	2. ENERGY EXCHANGES, PHYS. ENVIRON., LIVING COMMUNITY				✓							✓	✓	✓
	2.1 ENERGY INPUT, PHYSICAL ENVIRONMENT													
	2.11 ENERGY ABSORPTION, AIR, WATER, LAND													
	2.12 ENERGY EXCHANGES, CLOUDS, RAIN													
	2.13 ENERGY EXCHANGES, WINDS, WAVES													
	2.2 ENERGY INPUT, LIVING COMMUNITY				✓									
	2.21 SOLAR ENERGY, ABSORP., GREEN PLANT UTIL.				✓									
	2.22 STORED ENERGY, PLANS, ANIMAL UTILIZATION													
	2.23 ENERGY EXCH., DEAD PLANTS-ANIMAL, DECAY													
	3. INTERACTIONS, CAUSE AND EFFECT, ECOSYSTEM PARTS												✓	■

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